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Forthcoming Events.

FEBRUARY 9.

British Foundrymen's Association (London Branch).—"Brasses," by J. Edwards.

FEBRUARY 10.

British Foundrymen's Association (Birmingham Branch) *and Birmingham Metallurgical Society* (Joint meeting).—"The Life and Works of James Beaumont Neilson," by W. Macfarlane, F.I.C.

British Foundrymen's Association (Scottish Branch).—"Plasticity of Metals," by Prof. A. Campion, F.I.C., F.C.S.

FEBRUARY 17.

British Foundrymen's Association (Halifax Branch).—"Scientific Mixing of Iron for Castings," by Geo. Hailstone.

NOTES AND COMMENTS.

Foundry Specifications.

Foundry managers have often had occasion to complain of being required to comply with specifications for their work which do not take into consideration the essential features and characteristics of cast materials, and do not display any intimate knowledge on the part of the engineer regarding foundry conditions and possibilities. There is often a tendency to regard the founder as an unintelligent accessory to engineering work, who cannot be trusted to exercise his judgment in meeting engineering requirements, but who requires to be tied down to a written specification compiled according to the fancies of some outsider who probably knows little of the technical possibilities and limitations of the work. We do not for a moment suggest that the founder should not be required to work to specifications; but we do deprecate the lack of foundry knowledge which is often displayed by engineers in compiling specifications. Discussing the subject of steel specifications recently before the Junior Institution of Engineers, Major H. B. Strange remarked that in steel foundry practice it is not at all uncommon for locomotive castings, required for precisely similar duty and of practically identical pattern, to be manufactured alongside each other to separate specifications which are so worded that in one case the castings are condemned if their maximum strength exceeds a given number of tons per square inch, while in the other case the castings are condemned if the maximum strength does not exceed the same tonnage. The difficulty of supervision in these circumstances during the preparation of moulds before casting, and during the subsequent heat treatment of the castings, may be imagined. Nothing, he continued, is so exasperating to the manufacturer as having to make small batches of otherwise similar articles, each with some small difference in the specification which necessitates either a difference in the chemical constituents or more or less heat treatment, the actual differences in the specifications being, as a rule, entirely academical, representing the views of some individual engineer, perhaps deceased.

Probably, however, a more unfortunate feature of many such specifications is the opening which they afford to unscrupulous makers to provide castings which possess inherent defects, the specifications being accepted by one founder, while another, aware of the difficulty in producing really sound castings, has to make due allowance in quoting. The writer above mentioned pointed out that designs for steel castings are frequently submitted for the purpose of quotation, which conscientious manufacturers must refuse to quote upon, because from the very nature of the designs contraction strains are necessarily set up in the castings, which no subsequent treatment can reduce. The finished casting may to all appearance be satisfactory on the surface, but the experienced steel maker is aware that hidden flaws exist. When, therefore, manufacturers point out their difficulties to engineers, and in certain cases refuse

to quote to their designs, engineers should be very cautious before they decide upon accepting the quotations of manufacturers who take no exception whatever to any design. It should be well appreciated by all who have had any experience in foundry work that in regard to large steel castings, particularly, the designer has everything to gain by consulting the foundry, since the law of shrinkage in steel during cooling, though well known and comparatively simple, is by no means easy of practical application in the case of complicated designs. The practical experience of the foundryman and his advice as to what can be done and what cannot be done in casting steel, may be of the greatest use to the designer; for what may appear to be some trifling alteration may make all the difference between a good and a bad casting. Another point of considerable importance in designing mentioned by Major Strange, is that some steels show a better surface than others, and where the article is to be submitted to considerable friction it may be desirable to use these steels, although their toughness and tensile strength may be less. Again a steel with a very large amount of toughness may be readily distorted and lose its original form.

Many engineers will admit that the designer should also consult the founder as regards the treatment of castings after being taken from the mould; but they will probably not agree with Major Strange that they should seldom specify the chemical analysis of their steel, but should leave it entirely to the steel maker; and that the habit, which is not infrequent, of specifying the tests and also at the same time the chemical analysis of steel, should be abandoned. Nevertheless the contention is quite sound, provided that when the founder has recommended what he considers the best analysis for the work, the engineer takes steps to ascertain that the analysis is not widely departed from in practice. It is further suggested that the engineer should, in drawing up his specifications, request steel makers in whom he has confidence, and upon whose judgment and good faith he can rely, to advise him as to the nature of the steel he should adopt for the design. All steel makers have testing machines and laboratories attached to their works, in which thousands of test pieces are dealt with every month. The consequence is that they amass an immense amount of information as to the physical characteristics and peculiarities of the various types of steel which they manufacture, and are frequently able to give the engineer the best possible advice, when they know the type of work to which the steel is to be put. The whole question really resolves itself into that of co-operation between foundry and engineer; and though there is too often a tendency to view with scepticism the value of the foundryman's advice on engineering matters, it is well to remember that he possesses a knowledge of and a familiarity with the nature and properties of his material which can only be obtained by intimate contact with foundry operation.

"Elastic Limit" and "Yield Point."

In connection with the foregoing may also be mentioned the confusion which is often caused by the use in specifications of terms which, in their strict significance, are inapplicable, or which are indefinite in their meaning. As an example may be taken the terms "Elastic Limit" and "Yield Point"—terms which are used indiscriminately by many persons. Representations were recently made to the Engineering Standards Committee with regard to the use of the former term in their axle and forge specifications, with the result that "Yield Point" was substituted. A report since issued by the Committee contains standard definitions of these terms which have been unanimously agreed to. The definitions were as follows:—

Elastic Limit.—The Elastic Limit is the point at which the extensions cease to be proportional to the loads. In a stress-strain diagram plotted to a large scale it is the point where the diagram ceases to be a straight line and becomes curved. It can only be determined by the skilful use of very delicate instruments, and by the measurements of the extensions for small successive increments of load. It is impossible to determine it in ordinary commercial testing.

Yield Point.—The yield point is the point where the extension of the bar increases without increase of load. A practical definition would be that it is the load per square inch at which a distinctly visible increase occurs in the distance between gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger. A steel test piece at the Yield Point takes rapidly a large increase of extension amounting to more than 1/200th of the gauge length. The point is strongly marked in a stress-strain diagram.

The Sectional Committee on sections and tests for materials used in the construction of ships and their machinery, however, does not recommend the use of either "Yield Point" or "Elastic Limit" in the Standard Specifications for ship material, for the following reasons:—In regard to the ascertainment of the Yield Point there is considerable divergence of opinion as to the best method of determining it, and all methods involve greater time and care than can be expected in the works. While it is possible in works by careful testing at a greatly reduced speed to obtain the Yield Point in ordinary mild steel and wrought iron, some of the harder steels and other constructional materials have no definite Yield Point at all, and some have no Elastic Limit. It is quite impossible to determine the Elastic Limit in the time available for ordinary commercial testing. In its determination a specially delicate and accurate extensometer must be used, in the hands of a careful and competent observer, and the determination for each test bar would require a considerable time. It is properly a matter to be left to laboratories organised for scientific purposes.

The Ships Committee is of opinion that the present method of fixing, by experience, the working stress for any material as a proportion of the ultimate breaking stress rather than as a proportion of the Elastic Limit or Yield Point, is the best practical method.

The Chemist in the Foundry.

As the achievements of the chemistry add more and more, as the years go by, to the efficiency and perfection of manufacturing processes, it is not surprising to find the chemist cited as a necessity in the modern factory. In very many cases he is as necessary as any other operative, if economy and efficiency are to be considered, though in foundry work there is perhaps a tendency to rely too much on the guidance of the laboratory in solving working problems. Nevertheless, manufacturers frequently fail to appreciate to what extent the chemist can improve the efficiency of their processes by studying the chemical properties of their materials. Discussing the subject recently before the Congress of Technology, at Massachusetts, Mr. H. J. Skinner remarked that this was due largely to the fact that the older generation of manufacturers started as factory hands, and worked themselves up through the various grades to managerships. Their methods

were rule-of-thumb methods, and science had no meaning to them. With the growth resulting from the combination of capital and the technically trained men, conditions took on a new aspect, and the larger manufacturers, realising their debt to the chemist, and also that there are still unsolved problems in every factory, are securing the benefits of scientific advice. The smaller manufacturer, Mr. Skinner considers, will soon be forced to the same procedure or he will lose in the struggle for industrial existence. The rule-of-thumb method is passing. Guesswork is being replaced by scientific knowledge, and more and more consideration is being given to the underlying principles of manufacturing processes.

It is true that in pig-iron and steelmaking processes, for example, chemical control is essential at each step; and in all processes dependent upon the nature and condition of the raw material rigid inspection and control of such material is important as affecting the cost of the finished product. This is the work of the chemist or the testing engineer. But the question arises as to whether the advantages of employing a chemist permanently in the foundry are a sufficient return for the cost of that departure. Without question, in a big engineering work turning out a variety of work the outlay is well repaid; and in many a foundry of only moderate size a chemist could do much to adjust irregularities of practice, with good results. But while realising the undoubted value of the chemist, it may be disputed whether the claim made by Mr. Skinner that "a laboratory is just as essential to a factory as is an office, and the chemist is just as necessary as the auditor," can be strictly applied to the average foundry. It would perhaps be more correct to say that the foundry manager requires to have a good knowledge of chemistry and metallurgy, and that the application of this knowledge to foundry operations is essential for success. Once the practice of a foundry is established on the correct lines, the necessity for actual analysis of materials and products is not very frequent; it can be profitably introduced as a check on purchases and results, but with correct and careful control of the operations by a scientific manager, it does not become a daily necessity. The manager should possess many of the qualifications of the chemist, plus actual foundry experience and the power to apply both. Then the services of an analyst may be called upon when occasion demands, though he should be regarded rather as a specialist to be consulted in an advisory capacity than as a general solver of practical problems. The foreman or the manager should be in the best position to tackle the average foundry problem.

The Failure of the Scientific Expert.

In many works the employment of a chemist has been pronounced a failure, simply through too much being expected. In some cases manufacturers have engaged the services of technical graduates and expected them to solve any question in chemistry or metallurgy. This is an injustice to both the chemist and to the profession itself. As one writer recently stated: "The employment of a scientific man does not mean the engaging of a recent technical graduate at a salary of £3 to £4 a week to test raw materials, and report results which are probably erroneous to a foreman who does not understand them, but it means having a man of mature experience as a chemical adviser with two or three recent graduates as working assistants." In every case, if practical results are to be got, the knowledge of the chemist must be supplemented by the practical experience of the foundryman, and non-appreciation of this fact is accountable for much of the reserve with which founders regard chemistry. We repeat, however, that many managers, particularly of small foundries, may enjoy most of the assistance which chemistry can render if they will take the trouble to acquire the knowledge of chemistry and metallurgy which is now so readily obtainable without the necessity of studying through the laboratory.

Checking and Marking Patterns for the Foundry.

By J. R. M.

Before a pattern leaves the pattern department, it should be carefully checked over to see that it has been made according to the drawing, and that it can be moulded satisfactorily. It will also save the foundry considerable trouble if the interior sections be outlined on the pattern, showing the thickness of metal at the various parts, so that the position of runners and vents, etc., can be readily determined. In checking over a pattern, the overall and vital dimensions are first verified and ticked off with red crayon on the drawing. This system saves going over the same position twice, and any dimension not already checked is more readily detected.

The next thing is to follow out the way the pattern has been made to mould and suitably mark it, with the core boxes, so that the foundry will have no trouble in understanding the job. It may possibly mean the pattern being returned to the pattern-maker for correction, and it is here where the good judgment of a checker saves expense, as he must decide whether or not the error is so vital as to warrant the additional expense of correcting the pattern. Mistakes, however, should always be pointed out to the man who has done the job, and the necessity of keeping strictly to the drawing insisted upon.

For marking patterns, the writer prefers painting the symbols and location figures, in place of the usual stamping: not only do stamps deface the pattern, but very often are put in a position that makes against the clean draft of the pattern. Orange-red mixed with the best shellac varnish makes a good mark on patterns, especially on patterns that are painted black. These should always be brushed over with clear varnish after the letters are dry, to prevent them from being at any time erased.

Patterns with loose bosses should have their position marked on the pattern and painted with some colour that will contrast, and distinctly show the moulder that something is missing, if not already in position when the pattern is laid hold of for ramming up. The same applies to the core boxes, which should also have a lifter outlined on the outside, to show the coremaker which way the core is to be placed in the mould. Where fillets have to be rubbed, their size and position should be marked on the pattern and coreboxes. Coreprints should be marked or given a coat of paint to contrast with the colour of the paint on the pattern, and parts that have to be machined should also be stated, either by writing or painting on the pattern. Patterns that are left- and right-handed need to be carefully marked: facings can be initialled A B C, etc., their respective positions being marked on the pattern A.rh., A.lh., B.rh. B.lh., etc., so that no assuming a position is allowed on the part of the moulder.

It will be seen from the foregoing that the duty of a checker is not only to safeguard against mistakes in the pattern-shop, but also to prevent any misunderstanding liable to cause mistakes on the patterns being sent to the foundry.

Moulding an External-Flange Cylinder, or a Large Flange Pipe in Loam.

In making either an external-flange cylinder or an internal-flange cylinder, the tackle and procedure are somewhat similar, yet, in some particulars, they are widely different. In the following method with external flanges, the brickwork of the mould is re-made for each casting. The core spindle, spindle bottom, binders and cake plates are similar, but no core dish is required.

There are also ways of making large external-flange pipes and cylinders without disturbing the brickwork each time, if the number required warrants the making of the necessary tackle; these methods will be described later.

The dimensions of the cylinder under consideration at the moment are 6 ft. by 6 ft. by 1¼ in. thick (see Fig 1). Fig. 2 gives a sectional view of the assembled mould, binders and cake plates, etc., which differ from those for an internal-flange cylinder. Fig. 3 on the left-hand side shows the spindle and mould board in position for striking the bottom flange. The

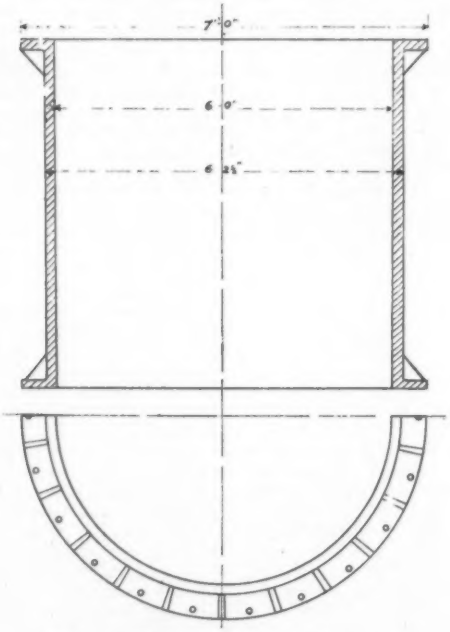

Fig. 1.—External-flange Cylinder.

right-hand side shows the completed brickwork. Fig. 4 shows the core board fixed to the stanchion and the spindle, with the bottom in the bracket, and the step for the core, which is bricked. The procedure is as follows:—

The bottom plate is levelled for the mould (A, Fig. 3), with provision for the spindle centre or step, due consideration being given to the height of the mould for the plank stoop or stand on top of the pit (see Fig. 3). The two fingers which form the top and bottom flanges on the mould board are set to size sticks. The top spindle centre hole in the plank is plumbed with a line to the bottom centre bar or step G, which makes the spindle and board perfectly parallel when put into position.

When the core seat H and the bottom flange are bricked, leaving ¾ in. allowance for loam, the joints between the bricks, which are not quite close, are filled with ashes, to allow the expanded gases to pass off. When the flange and seat have been roughed and struck up with finishing loam, the spindle and board are removed for drying; in the meantime the cake plate B, to cover the bottom flange (see Fig. 9), with recesses for brackets cast in, is struck up and dried, after which the centre is obtained by straight edge and trammels, and the divisions for brackets made by compasses are marked off and cut out in

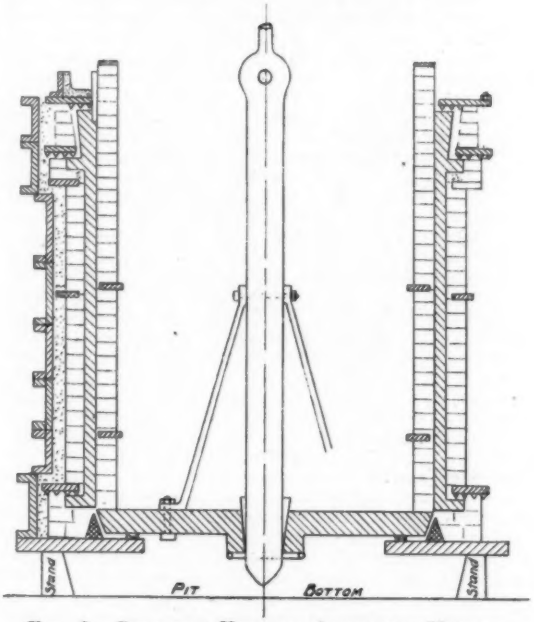

Fig. 2.—Sectional View of Assembled Mould.

the recesses provided. This cake plate is in halves and bolted together with fishplates, the bolt holes of which are set in the plate by a fishplate template, which is rather a convenient method, as it does away with drilling holes in either cake plate or fishplate.

When the bottom flange is dried, checked for size, dressed and blacked, the core holes, if any, are marked off by template provided, cut out, and cores put in. The bottom cake plate is turned over and lowered on to the bottom flange, care being taken that the brackets and holes are correctly divided and the cake plate accurately centred; the mould board is now replaced and the brickwork proceeded with. One binder, C, is sufficient in this length cylinder. When within one brick depth of the top flange, a plate to carry the flange is put on (D, Fig. 3), which is in halves, and is held together by two small cramps, in holes provided. This plate is also recessed for the top brackets, and when put on the brickwork one recess is plumbed to one of the bottom brackets

to ensure the recesses being in their proper position when the brackets are marked off. The top flange is bricked on this plate, provision being made for channels of ashes to carry off the gases.

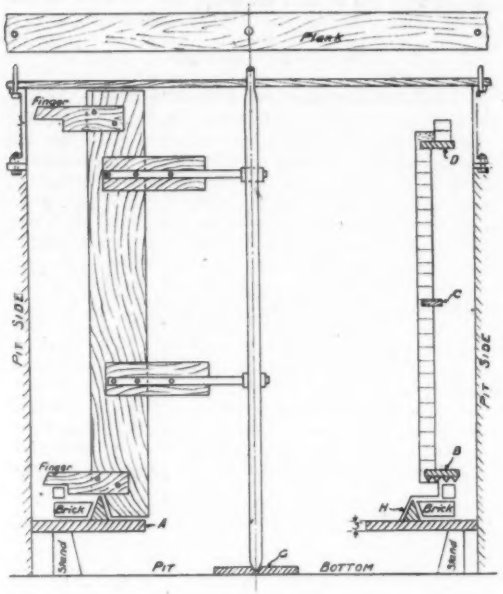

FIG. 3.—SPINDLE AND MOULD BOARD IN POSITION FOR STRIKING BOTTOM AND FLANGE.

The mould spindle and board are now withdrawn, and the brickwork dried with pan fires, after which

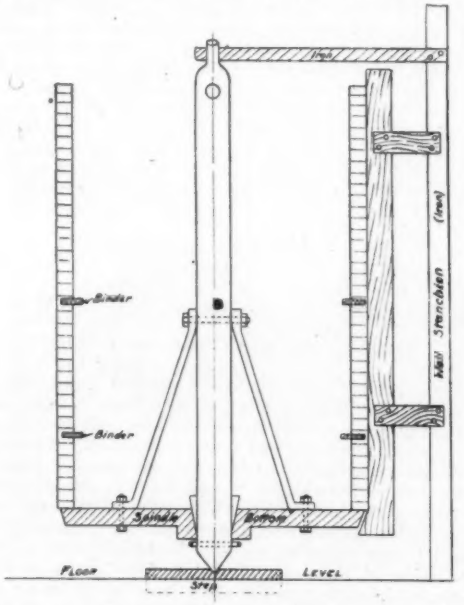

FIG. 4.—BRICK CORE; CORE-BOARD FIXED TO STANCHION.

the spindles and board are replaced and the brickwork roughed up while warm; the mould is struck off with finishing loam, the striking board withdrawn, and the bottom flange cleaned out, this having been filled in with floor sand while striking. After dressing and blacking, the mould is dried off, the top and bottom brackets plumbed, divided and marked off, and the template is put in for marking off the core holes;

FIG. 5.—FEEDING HEAD.

the brackets are cut and the mould is finished off.

The core is a bricked one, as shown in Fig. 4. A key barrel can be used if the number of castings required warrants its cost. The procedure with the

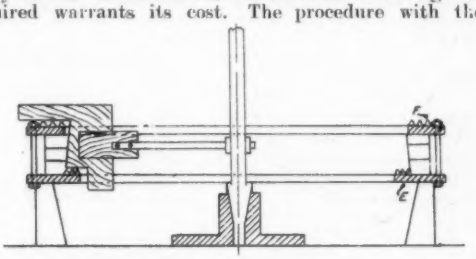

FIG. 6.—MOULDING THE FEEDING HEAD.

core is the same as with an internal-flange cylinder, with the exception that there is no top or bottom flange formed in the core, and, consequently, no top flange finger and no dish are required at the bottom. The binders, spindle and spindle bottom, bricking, striking, and drying are on similar lines. The feeding head, Fig. 5, is made separate. The top head plate, Fig. 7, is in one piece, with staples and runner holes cast in, and the inner part of the plate is prodded. On the plan view of this plate it will

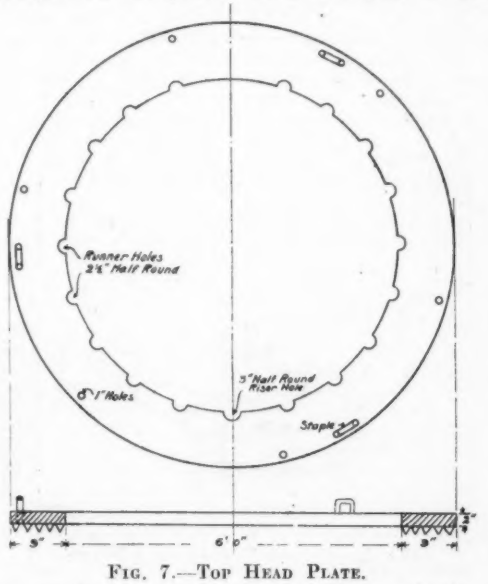

FIG. 7.—TOP HEAD PLATE.

be seen that six 1-in. holes are cast towards the outside edge of the plate. The bottom head plate, Fig. 8, is in halves, which are held together by two small cramps or plates when on the brickwork. This plate is larger in the internal diameter than the

top plate, and allows for the width of the head, which is tapered. It is prodded across, and has six 1 in. round holes cast in to correspond with the top plate for bolting together when bricked.

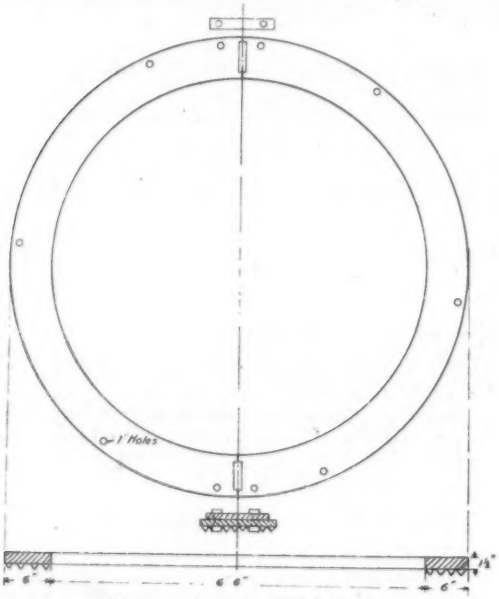

FIG. 8.—BOTTOM HEAD PLATE.

In moulding the feeding head (Fig. 6), the top plate (Fig. 7) with staples down is the bottom. A course of bricks is laid on the part of the plate not prodded, the bottom head plate (Fig. 8) is placed on

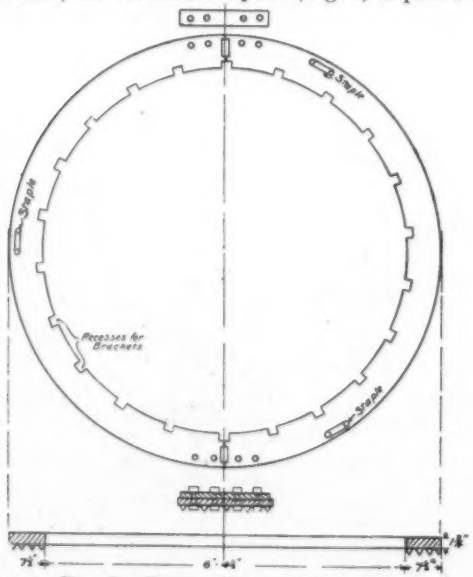

FIG. 9.—BOTTOM FLANGE CAKE PLATE.

the brickwork, as at F, Fig. 6, and bolted down to plate E, through the holes provided. The depth of head is determined before the feeding-head board is made, which board gives the distance between the plates E and F. When the head has been roughed, stiffened, finished, and stoved, it is dressed, blacked, and turned over; the runners and risers are filed, rasped or rubbed in, and it is ready for passing over the body core, which has been centred and forms the top of the flange and feeding head. The runner-box should not be less than 6 in. deep, and feeders should be used after pouring to ensure soundness.

Rustless Coatings for Iron and Steel.

Writing in the "Journal of Gas Lighting," Mr. M. Alwyne Meade, A.M.I.C.E., describes a system of "sand spraying" iron or steel to prevent corrosion. With this method a thin coating of fine silver sand is sprayed on to the paint while the latter is still wet. The paint is allowed to dry, another coat is then applied and this also sprayed with sand, and finally a third coat is put on, but the sand is not sprayed on to this. When the whole has thoroughly dried, the sand combines with the paint and forms a hard shell, which is very much better able to resist the inroads of the rust-producing agents. This method is particularly adapted for use with mild steel plates and rolled steel beams; and in all cases the writer recommends that the particular object being treated should be thoroughly scraped and brushed with a wire brush, and a coat of red-lead paint—without the sand spray—should be applied before the painting as suggested above is commenced. This coat should follow immediately after cleaning. As regards the apparatus for spraying the sand, it consists of a pair of bellows, a tin sand reservoir, and a small gas cock. The pipe from the reservoir leads into the blowpipe of the bellows, and a fan-shaped "spreader" is fitted to the bottom of the blowpipe. At the base of the reservoir is placed a gauze, which prevents the possibility of small lumps stopping up the feed-pipe; and to the underside of the reservoir lid is fitted a small flap-valve, which prevents the sand from being blown out at the top during the operation of spraying. A cock on the outlet pipe regulates the quantity of sand used. There are no refinements about the apparatus and nothing to get out of order. Moreover, it may be made complete for the modest sum of about 3s.; and the extra labour entailed by its use is neglible.

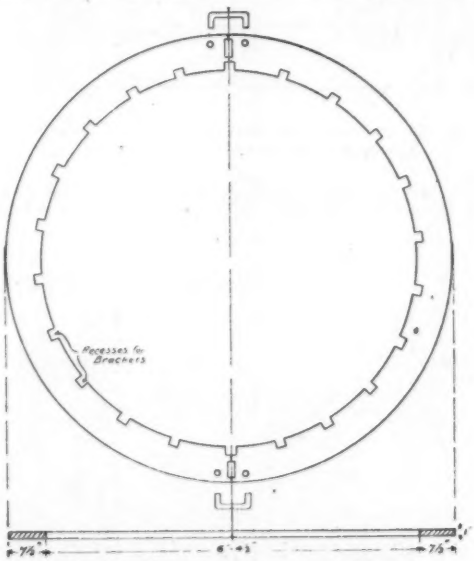

FIG. 10.—PLATE TO CARRY TOP FLANGE.

Oil Firing in Foundry Operations.*

The use of mineral oil as fuel for metallurgical purposes is by no means a modern innovation, for a report published in the year 1720 mentions that the natives of the Caucasus and the vicinity of Baku employed "black naphtha" for heating their furnaces. Originally, the oil was burned in troughs, but in the course of time burners were introduced which gave more economical results, one of the most efficient types being the atomiser, which has been successfully em-

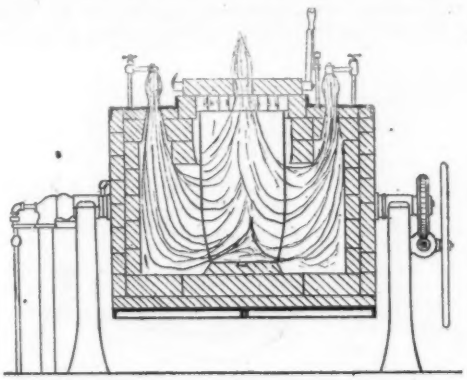

FIG. 1.

ployed for steam raising in locomotives, and—in a modified form, with compressed air instead of steam as the spraying agent—for metallurgical operations.

Oil fuel seems capable of successfully replacing coke for certain classes of foundry work, especially for non-ferrous metals and foundries turning out special, high-grade castings. In the former case, for example, considerable difficulties are experienced with coke-fired furnaces when castings of high and uniform quality have to be produced under guarantee; and the same occurs in foundries producing special-grade steel castings with less than 2.8 per cent. of carbon, as well as those working mild steel and having to turn out a compact, tough material at a profit. The

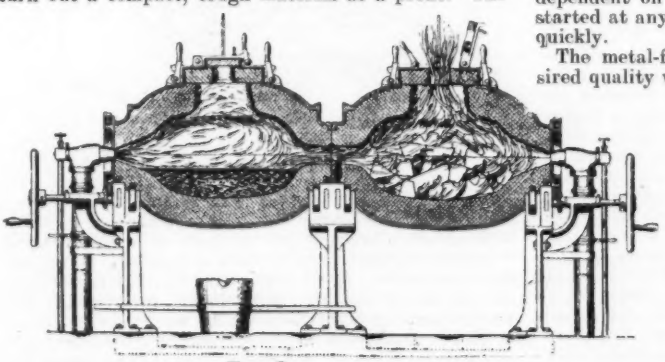

FIG. 3.

coke-fired furnace operated with natural draft is the best type of crucible furnace, because, if properly run, it will always furnish the quality of metal desired, the difficulty, however, being the absence of an efficient method of regulating the draft, which is dependent on the weather conditions. Moreover, the necessity for replenishing the coke fire at intervals is a drawback, owing to the liability of adversely affecting the working of the charge; and this risk is increased by the necessity for cleaning the fire. The excess of oxygen, essential to the maintenance of proper combustion, is also a frequent cause of oxidation of the molten metal. Bottom-blast furnaces, though quicker and cheaper to work, require the fire to be repeatedly cleaned, thus increasing the danger of oxidising the charge; and this risk is intensified by the omission, in practical working, to

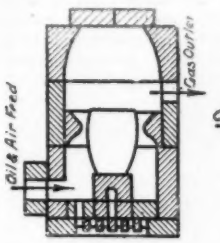

FIG. 2.

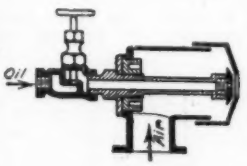

FIG. 2A.

modify the blast as the depth of the coke fire diminishes.

These defects of the coke-fired furnace can be rectified by the use of oil fuel. Furthermore, the storage space for the fuel is reduced by one-half, and conveyance is cheapened and simplified, all that is necessary being to pump the oil from the store to the furnaces either by hand or power. The fuel can be fed into the furnace with the utmost regularity, and the air supply controlled so that the smelting process is carried on in a uniform and complete manner. The supply of oil and air can be adjusted independently, and it is therefore possible to obtain any desired kind of flame and to work with a minimum excess of oxygen. At the same time the furnace temperature is also under complete control; there is no need for cleaning the fire; the working is not dependent on the chimney draft; the oil fire can be started at any time and will heat up the furnace very quickly.

The metal-founder can obtain castings of any desired quality with certainty, either in hearth or cruci-

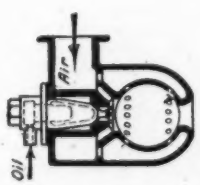

FIG. 4.

ble furnaces; and in the majority of instances the use of reducing agents, aluminium, magnesium, phosphorus, etc., is rendered unnecessary. It is even possible to melt chemically pure copper or nickel in the oil furnace, and obtain castings of perfectly compact structure without the aid of reducing agents;

* K. Schiel, Giesserei Zeitung.

and for many purposes the almost complete freedom of the flame from sulphur is an advantage that cannot be too highly esteemed. For temper castings a better and cheaper result can be obtained with oil firing than with coke, and at the same time a special grey cast iron with 2 to 2.6 per cent. of carbon, for which there is a good demand, can be produced. Founders producing mild-steel castings are often unable to attain the requisite heat for carrying on the process successfully; but, with oil fuel and hot air of combustion, it is practicable to attain to a temperature of 2,100 deg. C., without any notable effect on the carbon of the steel.

As regard the furnaces for use with oil fuel, Fig. 1 illustrates an American pattern, in which the nozzles are arranged on either side and directed downward, so that the flame has to reverse in order to escape from the furnace, passing round the crucible for this purpose. Whilst the fuel is utilised in a highly economical manner, the crucible ought to be mounted on a higher stand, so as to get more uniform heating; and a larger free space should be provided around the crucible. In Fig. 2, which is also an American

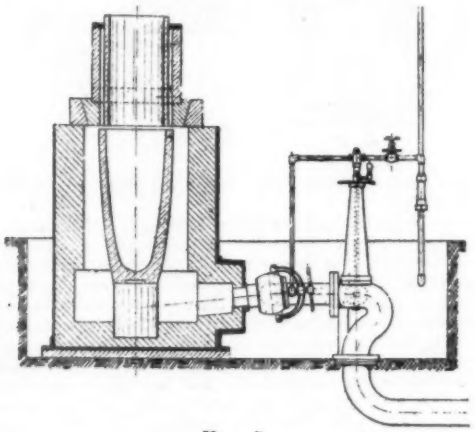

Fig. 5.

furnace, the oil flame is introduced tangentially; but this arrangement has the defect that the gas outlet is too low down, and would be preferably situated at a higher point in the furnace. Fig. 2*a* shows the burner nozzle.

Fig. 3 is a drum furnace which, though unsuitable for non-ferrous metals on account of the risk of oxidation and the great loss of heat, is well adapted for iron, the one chamber acting as a preliminary heater while the charge is being melted in the other, after which their functions are reversed. The furnace is tapped by tilting the drums. The same principle is adopted in the Schwarz furnace, which, however, is pear-shaped. The nozzles used in these furnaces are generally of the atomiser type; but Fig. 4 represents a form used in some German drum furnaces. The oil is supplied to the atomiser under a pressure of 3 to 4 atmospheres, and is sprayed by means of a Körting injector, which answers well for large-size nozzles, but is found liable to choke in smaller sizes. The air is admitted tangentially through three rows of holes, the one row acting in the opposite direction to the other. The resulting flame is very short, and is so hot at the tip of the nozzle that the latter is liable to burn away.

The Schmidt furnace is illustrated in Fig. 5. The downward slope of the flame is intended to bring it into proper contact with the crucible, from below. This furnace is said to answer well and to consume only a small quantity of oil. The burner is shown in Fig. 6. The oil is supplied by gravitation, and the air of combustion is blown in under a pressure of 12 to 16 in. water-gauge, through tangential slits, in order to produce a vertical motion. The Männel furnace is of similar character, but constructed mainly on American lines. The oil is atomised by compressed air under a pressure of 2 atmospheres, which makes the apparatus very noisy in working.

The Rosseau furnace, Fig. 7, differs from the ordinary crucible furnace in many important points. The crucible is pan-shaped and necessitates the tilting of the furnace. The flame is produced in a bottom chamber, separated from the actual heating chamber by a ring which contracts the sectional area of the furnace, thus ensuring efficient mixing of air and oil, holding the flame together, giving good com-

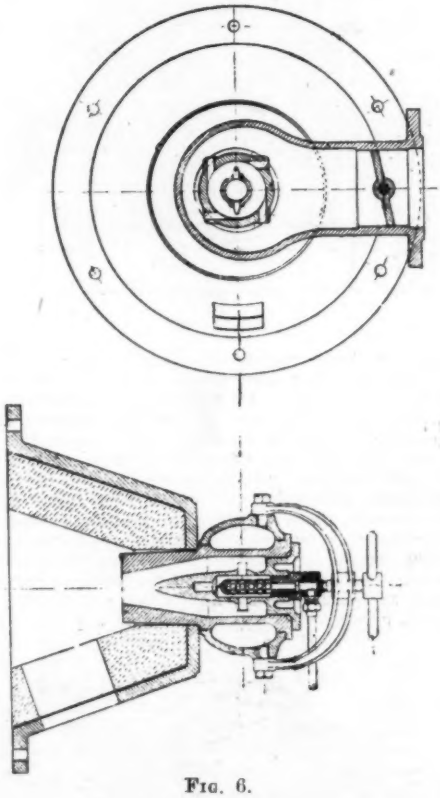

Fig. 6.

bustion and a good bottom heat. The oil is fed by gravitation, and atomised by air under a pressure of 3 to 8 in. water-gauge. In spite of its advantages, this furnace requires more careful handling than some other patterns. Every type, however, has its defects, though, unfortunately, users do not always take the trouble to counteract them by the use of greater care.

Fig. 8 represents a burner of the portable type, suitable for heating up cupola and hearth furnaces, drying casting ladles, heating drying ovens, etc. The oil is atomised by air under a pressure of 1 atmosphere. The bulk of the air of combustion is introduced through a pipe.

In choosing an oil furnace, it should be borne in mind that no one pattern of furnace or burner is suitable for all purposes, but must be selected for the purpose in view; and also that the type of burner

used must be adapted to the purpose and to the kind of furnace. The choice of a burner is the chief factor in obtaining successful results, a fundamental condition being the production of a very fine spray with a minimum of pressure, or gasification at the highest temperature, and careful mixing with the air of combustion. The dimensions of the furnace must be more carefully determined than is the case with gas-fired furnaces, it being borne in mind that the best effect is obtained with a given pressure inside the furnace. The flame should be guided so that it gives off the maximum of heat to the charge, and so that the radiation in the furnace assists the melting process. The supply of oil and air to the burner should be capable of independent regulation, since it is only by fulfilling this condition that a burner can be rendered suitable for different purposes. Atomising is facilitated by heating the oil to 80-90 deg. C., though in this connection the flashing point of the oil is the determining factor. The air should also be heated, since this assists in the attainment of complete combustion and the production of a short flame, besides preventing the undesired production of a coky deposit, in the crucible furnace particularly. This latter defect is almost always due to imperfect atomisation or insufficient length of furnace; in the latter case it can be counteracted by regulating the air supply so as to check the velocity of the entering current of oil. Detonation of the spray may be caused by an unsuitable type of nozzle, by heating the oil too highly, or by an excessive air supply, some nozzles allowing the oil to collect locally, where it suddenly ignites and produces detonation. This also occurs when gas bubbles form in the feed pipe.

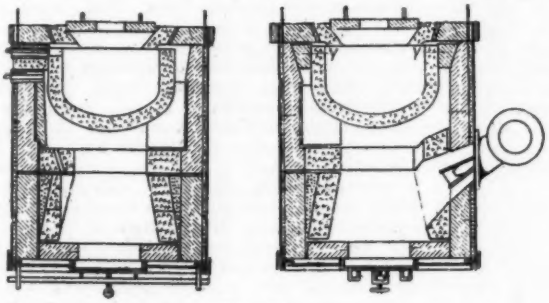

Fig. 7.

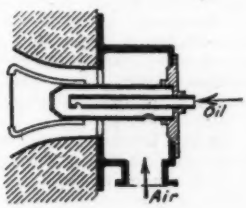

Fig. 7a.

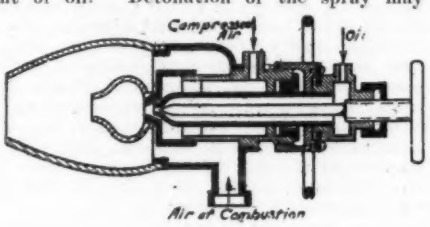

Fig. 8.

The practical results obtained in oil-fired furnaces are of a very satisfactory nature. Thus, the consumption of oil for melting 1 cwt. of metal is about 9 to 11 lbs. in the case of brass, 9 to 13 lbs. for red brass, 8 to 10 lbs. for aluminium, 13 to 17½ lbs. for grey cast iron with 2 to 2.6 per cent. of carbon, 16 to 22 lbs. for temper castings containing about 30 per cent. of wrought iron, 18 to 28 lbs. for nickel alloys with up to 25 per cent. of nickel, about 38 lbs. for pure nickel, and about 44 to 55 lbs. for mild-steel castings. These results were obtained in crucible furnaces with only one crucible, and working with unheated air of combustion. With heated air and larger furnaces the consumption of oil is reduced by nearly one-half, in the case of atomiser burners, whereas with drip burners the consumption is about 20 per cent. higher, and where open pans are used or the oil is allowed to trickle down the burner, the consumption is about 50 per cent. higher.

Comparison of a coke-fired bottom-draft crucible furnace with an oil-fired furnace:—Charge, 4 cwts.; coke consumption, about 88 lbs., costing 1s. 3d. Oil consumption, 50 lbs., costing (2s. 3d. per cwt.), 1s. 1d., and turning out metal of superior quality. Again, a crucible furnace for mild-steel castings, containing 4 crucibles, each holding a charge of 88 lbs., consumes about 5½ cwts. of coke, at a cost of 8s. 6d. A similar oil-fired furnace, with four crucibles holding charges of 1½ cwts., consumes 265 lbs. of oil at a cost of 5s. 6d. The time required for working a charge is small, 4 cwts. of aluminium, for example, being melted in 25 minutes, a similar weight of brass in 35 minutes, red brass in 45 minutes, grey cast iron in 65 minutes, 6 cwts. of German silver (25 per cent. nickel) in 90 minutes, and 6 cwts. of mild steel in two hours.

The oil fuel used in Germany is chiefly tar oil, costing 2s. to 2s. 9d. per cwt., according to the distance from the producing centres. The lowest heating value of this oil is about 8,800 calories. The output of the oil is about 450,000 tons per annum, in addition to which, a number of gas works produce an impure oil tar which can be purchased at 1s. 9d. to 2s. per cwt.

Coke-Oven Gas in Open-Hearth Furnaces.

During the discussion of a Paper read by Dr. Petersen, of Düsseldorf, at a recent iron and steel meeting in Germany, Mr. Amende, of the Hubertushütte, stated that they had used coke-oven gas in open-hearth furnaces for two and a half years with great success, sometimes as much as 70 per cent. of the coal being replaced by it. The durability of bulkheads and roofs decreased 8 to 10 per cent., but that of the checkers increased about 50 per cent. They ran 550-600 heats without repair work on bulkheads and roofs, and as high as 1,050 heats on the same checkers. The quality of the steel was not affected at all. In twenty-four hours, 1,800,000 to 2,600,000 cubic ft. of coke-oven gas were consumed. The coal consumption per ton of steel was reduced from 31.8 per cent. (1906) to 14.9 per cent. (1909) by the use of coke-oven gas. A blastfurnace gas main is under construction, and it is hoped to further reduce the coal consumption by this means. The coking coal is of poor quality, so that only 45 per cent. gas is available. The coke-oven plant contains ninety Otto-Hoffman ovens with a capacity of 320 tons of coal per twenty-four hours. The coke-oven gas analysis is:—6.5 CO, 1.2 O_2, 10.4 CO, 38.7 H_2, 16.4 CH_4, 24.8 N_2; B.T.U. = 377.

Cast Iron: Its Chemical and Physical Properties.

In a Paper presented before the Pittsburg Foundrymen's Association recently, MR. JOHN J. PORTER raised a point in connection with the selection of pig-iron which has thus far received scant attention, but which he considers worthy of most earnest consideration by foundrymen, viz., the great difference which exists in the behaviour of many brands of pig-iron and which apparently cannot be accounted for on the basis of chemical composition, as ordinarily determined. Without wishing to belittle the value of chemistry in the foundry or to deny the utility of analysis as a means of judging of the quality and fitness of an iron, he takes exception to the view still held by many chemists that analysis is *everything*, and maintains that there is something to be said for the arbitrary preferences of the older generation of founders. There are, he says, many irons which have practically identical analyses and yet showed marked differences in such important properties as strength and shrinkage. After citing various of his own experiments and other evidence supporting this, he continues:—

It is quite well known among both foundrymen and blast-furnace men that pig-iron made in whole or in part from mill cinder is less durable than that made entirely from ore, although the use of the mill cinder will not, as a rule, change materially the composition of the pig. The points of inferiority of cinder pig do not seem to be very clearly defined and have probably never been scientifically investigated. Nevertheless they are real enough to affect its sales value, and in England are recognised by the creation of the grades of cinder pig as opposed to all-mine pig. I have had some experience in the use of mill cinder in the blast furnace and have noticed that when using a considerable proportion of it, the iron was noticeably easier to break on the blocks, and there was invariably a decided increase in the unreduced iron in the slag.

Again, we have the case of charcoal iron, which in spite of the threats of foundry chemists to drive it from the field, is still produced in America to the extent of some 400,000 tons per year, and is still regarded as indispensable for many classes of work. As far as analysis goes, there is but little average difference and no essential difference between charcoal and coke iron. Charcoal iron averages lower in sulphur, but any coke furnace can, and often does produce iron with the sulphur down under 0.01 per cent., which is as good as is expected from charcoal iron. Again, charcoal iron averages somewhat lower in total carbon than most coke irons, but here again the difference is not universal and if we should judge by analysis only, many coke irons could easily pass as the product of the charcoal furnace.

Coming to the properties of the two materials, however, it is within the experience of almost every foundryman that there *is* a difference. This is perhaps most generally noticed in the matter of toughness or strength, which in charcoal iron is much greater, the grains having a tenacity which causes the iron to tear to a marked degree rather than break off short. It is also noticed, however, in the properties of shrinkage, tensile strength and depth and character of chill, and since there is such a difference in properties and such a similarity in composition, I think it safe to say that we have here a notable example of that elusive difference which escapes the arts of the chemist.

Although we may recognise the fact that differences in pig-iron may exist which cannot be accounted for by analysis, the explanation is a very difficult matter. It is true that the methods of metallography furnish a clue, and under the microscope the structure of cast-iron often shows remarkable variations. Cook found that strong iron showed under the microscope a peculiar net-work structure of the phosphide eutectic combined with much finer graphite than existed in the weak mixture. It is well known that charcoal iron is finer in grain than coke iron of similar composition and that this closer grain is an almost invariable accompaniment of strong iron. Hence, we may assume that a part at least of the differences in pig-iron is due to the variations in size, shape and arrangement of the graphite flakes. This is all right as far as it goes, but is only pushing the matter back one step and is not satisfactory as an ultimate explanation. It has been known for many years that the rate of cooling is an important factor in determining the percentage of combined carbon, and lately it has become appreciated that it may also affect iron in other ways than through the combined carbon. But though granting that the manner of cooling may produce many important changes, I still cannot believe that this theory is competent to account for the examples previously given. In the case of both Cook's experiments and those coming within my own experience, rate and manner of cooling were as nearly similar as it was possible to make them, and the number of pieces tested was too great to permit of the possibility of a coincidence of accidental variations in this factor. Moreover, the persistences of the differences after the remelting of the irons cannot be explained on this basis.

Another theory which may possibly be thought by some to afford an explanation is the manner in which the elements of the pig-iron are combined. There is, however, nothing to indicate that there is anything in this theory, and even if we could account for it on this basis, there would still be the question why two brands of the same elementary composition should have their elements combined in such different ways as to produce different properties.. Recently, considerable attention has been given to the gaseous impurities of steel and it has been found that nitrogen is a rather common and a very detrimental impurity. May it not be the case that the presence of more or less of this element, which is not determined in the ordinary analysis, explains the differences described? This appears a more likely explanation than any of those thus far cited. I do not, however, regard it as the right one, or at least the chief one. There is very little evidence either for or against it, but such as there is appears to be against it.

Perhaps the most generally accepted theory to account for otherwise unexplainable differences in cast iron is to assume the presence of variable amounts of oxygen in the metal. Perhaps the most conclusive evidence is the actual isolation of magnetic oxide from samples of iron which have been badly burnt on the hearth of an air furnace and which are known to have had the characteristics commonly attributed to oxidised metal. This theory fits in well with all that is known regarding the relation between blast-furnace practice and the properties of the iron made. For example, mill cinder is a particularly difficult material to reduce and it has a well marked detrimental effect on the quality of the pig-iron produced. While accepting as probably substantially correct this last theory, I would suggest that possibly a modification of it may be still nearer the truth. It is generally assumed that the oxygen is present as dissolved oxide of iron, but it seems to me possible, if not probable,

that it may be rather in the form of an oxy-sulphide of iron. This compound has been shown by Campbell to be capable of existing in iron and steel at high temperatures and to have remarkable powers of diffusing through the solid metal. Le Chatelier has also proven its existence. The evidence as to its presence and influence in commercial iron and steel is only indirect, but there is some circumstantial evidence pointing in that direction. In a Paper by Herbert Pilkington, read before the British Foundrymen's Association in 1911, it is stated that many of the best cold-blast charcoal irons contain 0.10 per cent. sulphur and upwards, and that this quantity which would be ruinous to ordinary pig, does not in this case produce unsoundness or other bad effects. Finally, I know of several observant foundrymen who are quite certain that sulphur is sometimes much more injurious than at others, and this fact, if such it be, may or may not be caused by its association with variable amounts of oxygen in the form of oxy-sulphide.

My observations have led me to accept as a tentative theory the rule that the less oxidising the conditions under which the iron is made, the better will be its quality. In other words, satisfactory iron should be made from easily reducible ores, with a moderate rate of driving and with not too much economy of fuel. These conditions, if correct, are rather hard on the furnace man, and it is to be hoped that further information may modify them somewhat. It is a significant fact, however, that in a large number of cases the irons having the highest reputation for low shrinkage and general good casting properties are made in small furnaces inadequately provided with blowing capacity and hence, lightly driven, and using brown hematite or other easily reducible ore.

It is a well-known fact that the grain of the pigs may be varied within wide limits without regard to composition by varying the basicity of the slag and the temperature of the hearth. It is also well known, however, that upon remelting the character of the grain is changed and becomes normal and, so far as I know, it has never been definitely shown that the size of the grain in the original pig bears any relation to the properties of the iron after remelting, at least none which cannot be explained on the basis of composition.

The question of the influence of brands upon fluid shrinkage is well worth the study of the practical foundryman. There are, of course, many foundries where neither fluid shrinkage nor high strength are of any particular importance, but on the other hand, there are some classes of work where one or both of these properties may be of very great importance, and in such cases a knowledge of brand characteristics is almost indispensable. As there is no published and very little privately held information along these lines, it is necessary for each founder to gather his own data, and the procedure which I recommend is as follows:—

(1) A fluid shrinkage and transverse strength test from each heat.

(2) A continuous record of the results of these tests and the mixtures used.

(3) Occasional tests of the different brands melted separately.

In regard to the test for fluid shrinkage, that originally recommended by Cook and consisting of a casting in the shape of a K, with the legs about 1 in. square in section, is very satisfactory. When this casting is broken at the junction of the legs, any tendency towards fluid shrinkage will be evident there. In using this test, it is convenient to construct a scale consisting of a series of from four to eight broken K castings of varying degrees of badness. These are mounted in a box and given suitable numbers. Thereafter it is sufficient to compare any test piece with this scale and to record its shrinkage, the number on the scale most nearly resembling it.

German Foundrymen's Association.

At a recent monthly meeting of the Berlin Section of the above Association, Herr Ernst Danneberg read an interesting Paper, illustrated with lantern slides, on the subject of "Up-to-date Appliances for Removing Dust, Ventilating and Atmospheric Heating in Foundry Work."

In his Paper, the author mentioned the unwelcome property possessed by air of mixing readily with dust, fumes and gases, the resulting impure atmosphere being then a source of inconvenience and damage to the surroundings. The best means of counteracting the evil is by the use of up-to-date methods of dust removal and ventilation. The dangers of dust from sandblasts and grinding machines were illustrated by photomicrographs.

The author next dealt with constructional details of the plant, ventilating fans, pipes, dust separators, and heating apparatus, and described plant for removing dust in the fettling shops, grinding shops, and sandblast shops, together with the method of drawing off acid fumes and foundry smoke, this last being very difficult to deal with, since the only rational system is to draw the smoke away direct from the point of origin. Hoods of various construction are used, including stationary, tilting, and crane-supported hoods, all connected in turn with the suction fan.

In conclusion, the important question of foundry heating was treated, the author expressing his conviction that the best method is that of heating the air of the foundry, being not only ideal in itself, but also meeting the pressing demand for ventilation in the works. In brass foundries particularly, the same plant can also be utilised for cooling the air of the shops. The ease with which atmospheric heating plant of this kind can be fitted up in the shops themselves was illustrated by a series of lantern slides, including views of the large casting shop at the imperial shipyard, Friedrichsort, and the new Jachmann foundry at Borsigwalde-Tegel. The Paper was followed by an interesting discussion, in which a prominent part was taken by Professor Brabbes, Professor of Heating and Ventilation, Charlottenburg Technical High School.

Inspection of Cores.

In repetition work particularly, it is important to institute careful and regular inspection of the cores. Only by such inspection is it possible to detect and prevent the use of cores made from boxes which have become worn and shifted, or cores improperly made or vented. If the cores are not properly inspected it frequently happens that a large number of cores are made in boxes from which a piece may have been lost or from boxes which are badly worn, or in which the sand is not properly rammed or with corners or edges knocked or worn off. The effect on the percentage of waste castings is too obvious to require emphasising.

Mr. T. Murphy, the Hon. Secretary of the London Branch of the British Foundrymen's Association has changed his address to 54, Rosebery Avenue, London, E.C.

Mr. J. A. Ewen, the Hon. Secretary of the Glasgow Branch of the British Foundrymen's Association, has resigned that position, as he has gone abroad. Mr. M. Riddell, of Etna Foundry, Falkirk, has therefore kindly taken up the duties of interim Hon. Secretary, and communications relating to the Branch should be addressed to that gentleman.

The Institute of Metals.

Annual Meeting in London.

The annual general meeting of the Institute of Metals was held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, on January 16 and 17 last. Owing to his sudden illness, the President-Designate (Professor W. Gowland, F.R.S.) was not able to be present for his inauguration. The chair was consequently occupied by a Vice-President of the Institute—Engineer Vice-Admiral Sir Henry J. Oram, K.C.B. (Engineer-in-Chief of the Royal Navy).

The Council reported a steady increase in membership, the number on December 31 being 586, including 555 ordinary and 27 student members. A special committee had been appointed to discuss with Dr. G. T. Beilby, F.R.S., a suitable scheme in connection with the research prize offered by him for the best contribution on "Foam-cell Structure," which he regards as likely to have an important practical bearing on foundry practice. Considerable progress had been made with the work of the Corrosion Committee, to meet the expense of which £302 had been promised.

The ballots resulted in the election of the following officers for the year:—

President.—Prof. W. Gowland (London).

Vice-Presidents.—Prof. H. C. H. Carpenter (Manchester), Mr. Summers Hunter (Newcastle), Prof. A. K. Huntington (London), Mr. W. H. Johnson (Manchester), Engineer Vice-Admiral Sir H. J. Oram, K.C.B. (London), and Sir Henry A. Wiggin (Birmingham).

Members of the Council.—Mr. L. Archbutt (Derby), Prof. A. Barr (Glasgow), Mr. T. A. Bayliss (King's Norton), Mr. G. T. Beilby (Glasgow), Mr. G. A. Boeddicker (Birmingham), Mr. R. Kaye Gray (London), Mr. George Hughes (Horwich), Mr. R. S. Hutton (Sheffield), Mr. J. T. Milton (London), Mr. W. Murray Morrison (London), Mr. G. H. Nisbett (Prescot), Mr. Panizzi Preston (London), Dr. W. Rosenhain (Teddington), Mr. A. E. Seaton (London), Mr. Cecil H. Wilson (Sheffield), Prof. T. Turner (Birmingham), Sir W. H. White (London), Sir G. A. Muntz, Bart. (Birmingham), and Mr. G. Shaw Scott (Secretary).

In Professor Gowland's absence, his address on the subject of "Copper and its Alloys in Early Times" was read by the Secretary (Mr. G. Shaw Scott, M.Sc.). An abstract of the address appears on another page, while herewith are given in brief abstract a number of the Papers presented.

A Study of the Properties of Alloys at High Temperatures.

In this Paper, submitted by Mr. G. D. Bengough, M.A., a series of tensile tests on selected metals and alloys are described. The tests were carried out at temperatures varying from the ordinary temperature to the neighbourhood of the melting points of the materials used. A special form of apparatus was used for the tests, and a full description of it is given in the Paper. A number of unexpected results have been obtained. The curves showing the variation of mechanical properties with temperature show certain "mechanical critical points" in the neighbourhood of which the direction of the curves alter rapidly, and this phenomenon occurs even in the case of commercially pure metals such as copper and aluminium. A theoretical explanation of the shape of the curves is proposed and discussed.

The Influence of Oxygen on Copper containing Arsenic or Antimony.

The experiments described in this Paper, by Mr. R. H. Greaves, B.Sc., were made to determine the influence of oxygen on certain mechanical and physical properties of copper containing either arsenic or antimony in quantities up to 0.5 per cent. A number of comparative tests in which the metals were cold-rolled down to 0.02 in., or drawn into fine wire, showed that with increasing arsenic, the metal may take up more and more oxygen without suffering deterioration in its capacity for rolling. This quantity of oxygen increases from about 0.05 to 0.2 per cent. as the arsenic increases from 0 to 0.2 per cent., then more slowly to about 0.28 per cent., with 0.05 per cent. arsenic. Above this point the malleability falls off, and with still more oxygen the metal becomes "cold-short." The action of oxygen on copper containing antimony is similar, but in this case a small quantity (about 0.1 per cent.) effects a distinct improvement in the malleability of the metal. The ductility was similarly affected by oxygen. Tensile tests on the case metals showed that increase in oxygen from 0.15 to 0.4 per cent. caused a rapid diminution in elongation; the effect on the maximum stress was not marked. Oxygen has little effect on the hardness (measured by the Shore scleroscope) until a limit is passed, depending on the arsenic or antimony present; above this, the hardness increases rapidly. This limit is at about 0.3 per cent. with 0.4 per cent. arsenic, but is less in presence of antimony. The first addition of arsenic or antimony decreases the hardness of copper containing oxygen. Measurements of electrical resistance show that oxygen diminishes the conductivity of copper containing arsenic, but increases that of copper containing antimony; the quantitative effect of the oxygen has not yet been determined. In an appendix, methods of determining oxygen in copper are discussed. Without denying the accuracy of other standard processes, the author suggests that oxygen may conveniently, and with a high degree of accuracy, be determined by reducing in hydrogen, and weighing the water formed.

A Note on the Nomenclature of Alloys.

In this Paper, Dr. Rosenhain, B.A., raises the question of the nomenclature of non-ferrous alloys and puts forward some tentative suggestions to serve as a basis for discussion. He draws attention to the confusion in nomenclature which exists at the present time, particularly as regards such terms as "brass" and "bronze" which are frequently applied in contradictory ways. A system of nomenclature is put forward for consideration in which alloys are classified according to the system of binary alloys to which they approximate most closely, and class names for such binary systems are advocated such as the term "Brass" for alloys consisting principally of copper and zinc; "Bronze" for alloys consisting principally of copper and tin: and so on. The additional metals present in any particular alloy would be indicated by additions to the class name, so that an alloy consisting of copper and zinc with a comparatively small percentage of manganese would be called a "manganese brass." Some of the difficulties which have to

be overcome by such a system are pointed out, and the suggestion is made that the whole subject should be dealt with by a representative Committee of Members of the Institute, who should be asked to draw up a system of nomenclature for use in scientific and industrial work, particularly in specifications. Dr. Rosenhain adds that he does not wish to interfere with ordinary trade names used in connection with the advertisement and sale of alloys of special properties, particularly when these are non-descriptive, but generic names, such as "brass" and "bronze," should be used accurately, and a satisfactory and widely recognised system of nomenclature is none the less desirable.

The Behaviour of Certain Alloys when Heated in Vacuo.

In the course of a Paper on the above subject, the author, PROFESSOR T. TURNER, M.Sc., says it was observed, during the course of some experiments conducted a year ago, that on melting brass in vacuo, the whole of the zinc volatilises, leaving the copper. This separation is quantitative, if the heating is not too prolonged and the temperature not above 1,200 degrees C. The behaviour of other copper-zinc alloys when similarly heated was, therefore, investigated. A sample of "poisoned" brass—*i.e.*, brass containing iron, lead, tin, arsenic, and other impurities—was heated in a porcelain tube in vacuo at 1,200 degrees C., and the residue examined. All the zinc, lead, and arsenic, and a little of the tin, volatilised leaving a residue of copper, iron, and most of the tin.

Larger scale experiments are also described, in which 70/30 brass was melted in a crucible, transferred to a large and well-lagged desiccator, and the whole quickly exhausted. The residue in the crucible was cooled and analysed, and the loss in zinc recorded. As a result of these experiments, it is suggested that heating in vacuo might be advantageously applied for the refining of crude copper, brass scrap, etc. "Hard" zinc may be refined by heating in vacuo to 500 degrees C., *i.e.*, to a scarcely-visible red heat. Hard zinc is the residue from galvanising baths, and contains about 5 per cent. of iron. At higher temperatures some iron is carried over with the zinc, but at about 500 degrees C. all the iron remains in the residue. As the temperature necessary is so low, and as there is no loss of zinc by oxidation, there is reason to believe such a process would be commercially successful.

Some preliminary experiments on the equilibrium between zinc vapour copper and copper alloys are also described. Zinc itself volatilises easily at 375 degrees C., in vacuo. A 60/40 brass readily loses zinc at 520 degrees C., and a 70/30 brass at 550 degrees C. On heating zinc with copper in vacuo, the metals not being in contact, the copper rapidly turns yellow at 380 degrees C., whilst the zinc is still solid, enough zinc volatilising to form a surface layer of brass. Zinc distils readily in glass vessels in vacuo, the vapour being colourless and transparent. The zinc condenses in globules having the appearance of mercury.

Further Experiments on the Critical Point at 470 Degrees C. in Copper-Zinc Alloys.

In this Paper, by PROFESSOR H. C. H. CARPENTER, M.A., Ph.D., it is shown that the so-called beta constituent in copper-zinc alloys is to be regarded below 470 degrees C. as an extremely minute and uniform complex of alpha and gamma particles. Its structural stability is so remarkable that even after six weeks' annealing at 445 degrees C., no appreciable coalescence of these particles has been observed in an alloy of exactly the eutectoid composition. When, however, a few crystallites, either of alpha and gamma are initially present in an otherwise pure eutectoid alloy, then, on annealing at 445 degrees C., this stability is comparatively easily destroyed. These crystallites constitute nuclei for the deposition of alpha and gamma, as the case may be, from the mixture, and eventually in both cases the final result is the same, viz., coarse alpha and coarse gamma, which can be seen with the naked eye, which have characteristic colours, viz., alpha pale gold, and gamma pale bluish-grey, and which have the same etching properties. The peculiarly persistent structural stability of the pure eutectoid alloy can be explained by supposing that at the inversion temperature on cooling, the resolution of beta into alpha plus gamma takes place throughout the entire alloy almost, if not quite, simultaneously. This constitutes a favourable condition for the production of the inversion products in an amorphous form, because the forces operative in crystal production do not have time to come into play. This view is in harmony with certain peculiarities which the freshly-prepared alloy exhibits both in polishing and etching, which disappear when it has passed into a visibly crystalline condition. Further, the structural stability of the eutectoid alloy has been so much diminished by the presence of 4 per cent. of aluminium, that after two days' annealing at 445 degrees C. it was found to have undergone the typical lamella inversion such as is shown by the iron, iron-carbide eutectoid pearlite. These facts constitute overwhelming evidence that below 470 degrees C. the beta constituent in copper-zinc alloys consists of the two-phase system alpha plus gamma.

The Effect of Tin and Lead on the Microstructure of Brass.

In this Paper the author, MR. F. JOHNSON, M.Sc., records the results of experiments made with the object of ascertaining the structural relations which exist between lead and tin when present in brass where the ratio of copper to zinc is 2:1. He found that, by itself, tin was thrown out of solution in the alpha phase (70 copper, 30 zinc) in the form of a hard pale-blue compound (probably $SnCu_4$) some time after solidification of a slowly-cooled alloy. Annealing, either preceded by rolling or not, enabled this compound to again pass into solution in the alpha phase. In a brass consisting of the alpha and beta phases, where the latter was present in sufficient amount (*e.g.*, Naval brass and Muntz metal) the copper-tin compound was much more soluble, being apparently retained by the residual beta. In an alloy where the beta phase exists in an unstable form (such as the alloy containing 2 parts copper to 1 part zinc) it is insufficient in amount to retain the tin compound, which is deposited mainly as a thin envelope or film separating the beta from the alpha phase, thus giving a reticulated appearance to a polished and etched section. With regard to lead, the author found that this acted independently of the tin, exhibiting behaviour similar to that of lead in ordinary brass or in copper. That is to say, it retained its individuality and existed in small particles unalloyed with more than mere traces of any other metal, these particles tending to segregate towards the areas last to solidify. In the presence of excess of the beta phase, lead is probably held in solution therein. As a result of the observation, the author strongly advocates a very thorough annealing of all cast material of the 70/29/1 and 62/37/1 compositions (Admiralty and Naval brass respectively) before subjecting it to rolling or drawing, in order that the brittle tin compound may be enabled to pass into solution.

Modern Foundry Machine Appliances.

Address before Halifax Foundrymen.

A well-attended meeting was held at the Municipal Technical College, Halifax, on Saturday, December 16, to hear and discuss a Paper by Mr. H. S. Green, of London, on "Modern Foundry Equipment." Mr. H. Campbell, President of the Branch, was in the chair, and briefly introduced the lecturer.

Mr. Green's Paper was profusely illustrated with lantern slides and specimen castings. Many of the machines and appliances described have already been dealt with in our columns. The following are a few extracts from the Paper, which, on account of considerations of space cannot be dealt with in full :—

Sand Preparing and Handling.

This part of foundry work has received less attention than any other, and yet good castings depend to a large extent upon the selection and preparation of the sand. Nature has provided this country with good sands in many districts, and we have been so busy in turning out castings that little attention has been paid as to whether by the use of suitable machinery for preparing the sand, not only might the quality of the castings be improved, but also considerable economies be effected by using less new sand. On the Continent they have not such good sand in a natural condition, and therefore, in order to secure suitable sands for their work, they have had to spend a considerable amount of time and money in experimenting as to the most suitable mixtures and the machines necessary to prepare these in order to get the best results. In most cases they cannot take one sand and use it universally for all their work. In one instance a firm uses three qualities of sand and four different mixtures or combinations of these sands.

To obtain a clean skin, not pitted on the casting, the grains of the sand require to be evenly graded; the coal dust must be very fine, the old and new sands mixed perfectly, and the whole having the alumina evenly distributed. To obtain this even grade of sands, screening and milling the sand are essential. I am aware that the present method employed is wet-milling in an ordinary pan mill; but, in my opinion, this does not give such good results as milling the sand dry, as it cannot be screened so effectually. After the milling and screening process, the sand requires to be tempered and mixed, and when several qualities are to be used in combination it is practically impossible to obtain an intimate and even mixture of the sand other than by mechanical means. Amongst the general improvements and discussion that is now going on in foundry work this subject is also receiving its share of attention, and amongst the factors that have brought it to the front is the increasing number of power moulding machines that are being used and the extension of the use of the sand blast. Power moulding machines require a more open sand than is used for hand moulding, and this openness or porosity can only be obtained by machine preparation. The sand-blast exposes the imperfections, and demands that more attention shall be paid to the facing sand.

Moulding Machines.

The advantages over hand work which result from the use of moulding machines are (1) increase in output, (2) greater uniformity of the castings, and (3) superior finish. In the average works having a foundry to supply their own castings the machine-moulded castings can be delivered to the machine shop at a quarter the cost of the same castings if moulded by hand, as in addition to the saving in the cost of moulding there is also a great saving effected in the cost of fettling, for castings made on machines from good patterns and boxes require

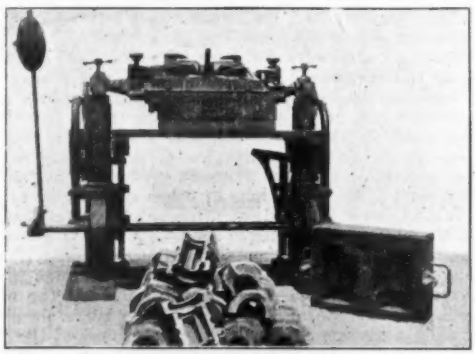

FIG. 1.—HAND-RAMMING TURNOVER MACHINE; MOULDING TRAMWAY AXLE-BOXES.

practically no chipping nor filing. With a machine the pattern is always drawn perfectly true, with the consequence that the castings are absolutely uniform and accurate. In some instances, owing to the greater uniformity of the castings, the saving in metal alone warrants the laying down of a moulding-machine plant.

The scope of the moulding machine has been broadened tremendously the last few years. Only a short time ago it was considered impracticable to do much larger work than would go in a 24 in. square box. To-day that size is normal, and ma-

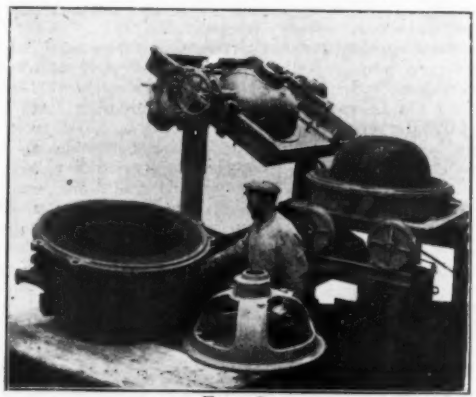

FIG. 3.

chines for boxes 7 ft. square, weighing 30 tons, for boxes 10 ft. by 6 ft. and even larger are being made, sold, and found to be a paying investment. You can now get machines to draw anything up to 30 in. and even deeper if desired, and to make castings from a stair eye to a locomotive driving wheel.

Hand-Ramming Turnover Moulding Machine

Fig. 1 shows an extremely handy machine, and although at first sight it does not impress one very much, the more we know it the better we find it to be. You may say it only draws the pattern, and all the ramming of the mould has to be done by hand. True! But it draws the pattern perfectly, and saves all the time used in slicking, patching and swabbing. A labourer can learn to ram a mould very quickly, but it takes long experience to make him proficient in the use of tools. There is a further saving in patterns. A wood pattern on a hand ramming machine will last three times as long as if used for hand moulding, and on power machines—well, in some cases thousands have been made from them and they have still been good. It depends to a large extent upon the care exercised in removing the patterns from the stores to the machine and back again. The boxes are turned over before the pattern is drawn, and is in its right position for the floor. This system of moulding is particularly necessary where there are loose pieces or deep pockets of sand.

Fig. 2 shows pattern-plates that have been made and supplied for machines of this description; two pairs of pattern-plates, one 28 in. by 16 in., the other 36 in. by 31 in., showing parts for turnstiles.

Power Drawing.

Where deep patterns are being used, or with large machines, the weight of the turnover plate with its accompanying moulding box full of sand is too much for a man to lift speedily by mechanical means, and we therefore recommend that in these cases hydraulic power be employed for drawing the pattern. If the machine is fairly small it can generally be arranged to work from the town supply, but for large machines, and where a number are likely to be used, we recommend a pump and accumulator to be installed. The drawing of the pattern can be done in either of two ways:—(1) By lifting the pattern out of the sand from above, the box remaining firm, similar as in hand moulding; or (2) by lowering the box away from the pattern, the pattern plate remaining firm. Both methods are employed, the first for very high patterns and large boxes, the second for shallow patterns. The first type of machine has several advantages, especially for deep boxes, as it can be built lower than the second type of machine, and thus ensures a comfortable working height; and, further, the pattern plate being guided by a ram on each side, a steadier draw is obtained.

Fig. 3. shows a machine of the first type fitted with pattern-plates for making bearing end shields for motors. The boxes are 44 in. in diameter by 26 in. and 6 in. deep. Two men turn out 10 complete castings per day. This machine has been built in a large number of sizes to take boxes up to 10 ft. long.

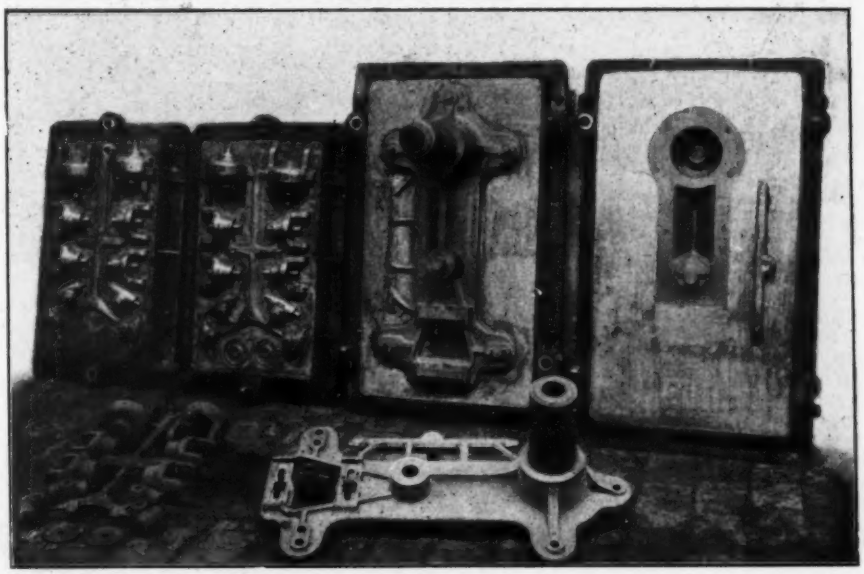

Fig. 2.

Power-Operated Turnover Plate Machines.

Turning now to machines of the same type, *i.e.*, fitted with a turnover plate, operated by power, the advantages obtained lie in the increase of output secured, in the greater uniformity of the rammed mould, and, to a lesser extent, in the saving in pattern repairs. As a hand ramming machine saves that part of the hand moulders' work which occupies the greatest time, *i.e.*, the drawing of the pattern and patching up of the mould, so a power machine saves that part of the hand machine operator's work which takes longest, *i.e.*, the ramming of the moulds. At first sight the saving effected does not appear very appreciable, and hardly warrants the power installation; but when the question is gone into thoroughly it is usually found that the power machine saves at least 75 per cent. in time, whilst the moulds are rammed with greater uniformity. Therefore an ample margin is usually found to pay the cost of the power installation, which in the case of hydraulic machines is remarkably small.

In addition to the advantages peculiar to the turnover machine which have been mentioned is the fact that bottom and top boxes are made alternately, the patterns being arranged on each side of the plate. With this arrangement any cores necessary can be set in the moulds and the boxes

closed at once, thus saving any chance of damage and obviating the necessity of blowing out the moulds before closing.

On the right of Fig. 4 is seen a hydraulic turnover machine, and on the left a hydraulic core-making machine. The moulding machine is fitted with patterns for making two quarter-bends, and as may be observed, the core machine makes one long core for

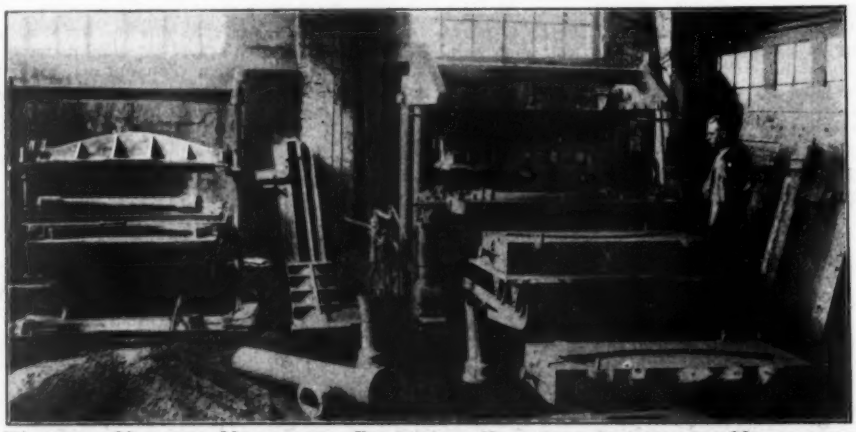

FIG. 4.—HYDRAULIC MOULDING MACHINE (ON RIGHT) AND HYDRAULIC CORE-MAKING MACHINE (ON LEFT).

fitting right through the box. On the side can be seen the pattern-plate for making a flanged branch pipe. The core iron used in the core is lying at the foot of the core machine, as are also the core boxes for the branch pipe. Sizes of boxes 55 in. by 22 in.; output, two men four complete boxes per hour. Core machine, one man six cores per hour.

There is one machine which cannot be said to come under the headings of any of the machines so far considered. This is known as the "Boxless" moulding machine, because it dispenses with the use of molding boxes. It was first brought out by Leeder, the foundry manager of the Singer Company, Kilbowie, many years ago, and although a considerable number of improvements have been made on it since then, the main idea of the machine remains. It was evolved to produce large quantities of castings with rapidity, and to do away entirely with the use of both moulding boxes and snap flasks. Two permanent boxes are fitted to it, one above and one below a swinging plate. There are also two rams, one inside the other, so as to ram both the top and bottom boxes simultaneously. The rams are operated from separate valves attached to one main supply pipe. In actual practice the moulds are produced quicker than I have been able to describe the process to you.

Many a good machine has been condemned and scrapped through no fault of the machine itself, but through the equipment provided for it. Unless patterns are suitable for the machine and the equipment right, most of the efficiency is lost. Too much cannot be said in favour of good equipment, for upon it nearly the whole of the success or otherwise depends. The best machine with poor equipment will turn out bad work, whereas an indifferently-designed machine fitted with well-made boxes, patterns, etc., will turn out some really very good work. A great deal of the trouble experienced by moulding machine users can be traced to improper equipment. For instance, you give a moulder a pattern a little undercut; when he finds it will not draw he knocks away with the rapping iron until he enlarges the mould sufficiently to allow the pattern to be drawn. Now, such a pattern mounted on a machine is bound to cause trouble, for although a machine may draw a pattern without any taper, it certainly will not draw when the pattern is undercut. The machine draws straight and true, and any rapping you can give either by hand or power is only sufficient to slightly loosen the sand, and certainly not sufficient to allow an undercut pattern to be drawn without breaking or fraying the mould.

Stripping Plate Machines.

With stripping plate machines the pattern is arranged to be drawn through a plate that encircles

FIG. 5.—TELESCOPIC PULLEY-MOULDING MACHINE.

it perfectly, and which supports the sand at every point of the outer edge, so that moulds of absolute accuracy are produced. They are particularly suitable for making gear wheels of all descriptions,

pulleys, and similar classes of work. For ordinary castings their great disadvantage is the high cost of preparing the patterns.

Fig. 5 is the latest type of pulley machine, all the rim patterns are stored in the machine itself; the time necessary on other designs to change from one rim pattern to another is saved; and changes from one side to another can be effected very speedily, enabling the machine to make a variety of sizes in the same day.

Fig. 6 shows a stripping-plate machine and a lever press machine working in conjunction, the stripping-plate machine making the top boxes whilst the lever press machine makes the bottom boxes. Noticeable features are the fine teeth required for these wheels, and the splendid results obtained in moulding. However clever a moulder may be, he could never touch up a mould to make it as accurate as shown in the illustration.

Fig. 7 shows a bench stripping-plate machine fitted with patterns for making malleable-iron radiator nipples.

In conclusion, the lecturer exhibited views of cleaning room equipment, and also a suggested arrangement for a foundry having a yearly production of 1,500 tons of castings.

Discussion.

The CHAIRMAN said they had had a great number of excellent pictures illustrating the modern processes of sand-blasting, moulding machines, and foundry lay-out, some of which no doubt had opened their eyes as to the way in which things were being done on the latest methods, not only in England, but on the Continent as well. They would not appeal, of course, to those who had to do general work, but only to those engaged in foundry work itself. It was by perfecting small apparatus that they could go on to larger, and he had no doubt that in years to come they would be using very much larger moulding machines than they had at present. At the same time he was afraid the cost of such appliances might appear to many people almost prohibitive, though perhaps in future they would become cheaper.

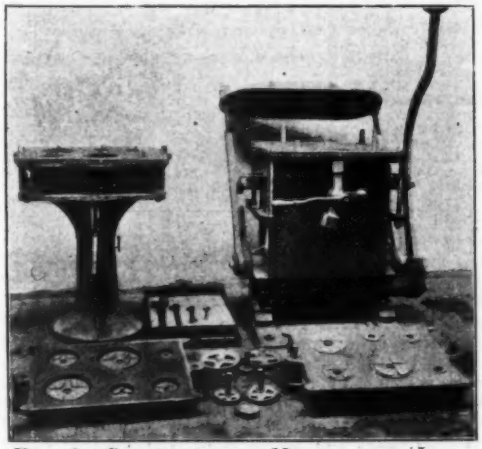

FIG. 6.—STRIPPING-PLATE MACHINE AND LEVER-PRESS MACHINE FOR SMALL TOOTH WHEELS.

MR. CARRICK said he had a number of questions he wished to ask, but in his opinion the better way would be for him to put them in writing, and request Mr. Green to answer them hereafter, and they might then be considered at another meeting. In regard to the sand-mixing apparatus, he would have liked the lecturer to have dealt rather more fully with the question of cost, which was a very vital point. The plant seemed to him to be very elaborate, and perhaps Mr. Green would send them further particulars, so that they could compare the outlay with the cost of laying down the present sand-mixing machines. Then, as to milling sand dry, he thought most of them would agree that to mill the sand in its damp state would prove the better course. Would Mr. Green kindly explain the method of making the reversible plates which he had described. It would be almost impossible to make them from plaster blocks, for they would have to get the tops and bottoms in an exact position on one line. With regard to boxless moulds, did he put a casing on afterwards.

MR. GREEN, in replying, said that as to milling, dry or wet, there was one point to remember, namely, that they could not grade the sand when it was wet, but they could when it was dry. The reversible plates had been made in plaster with white metal, but the process was really too long to describe, there being about twenty operations. Indeed, he had been obliged to pass over very rapidly many things, each one of which would have afforded material for a separate paper. The plates, as he had just stated, were made in plaster, but they could ensure absolute accuracy. In the boxless machine a divider of wrought iron was used for the bottom box, but only in large sizes. With respect to axle-box cores, some cores could not be made on the machine at all, but a Great Central Railway axle-box could be so made. They had not yet got a moulding machine that would do every class of work, and there were still some kinds of work which were done better by hand, but they must not say, therefore, that machine moulding was not good. It depended upon the individual casting that was being dealt with.

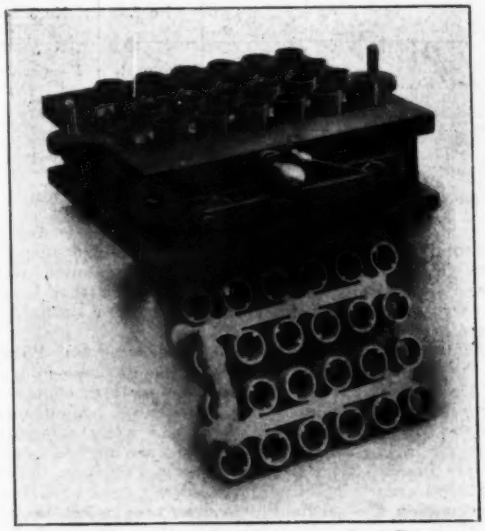

FIG. 7.—STRIPPING PATTERN-PLATE FOR RADIATOR NIPPLES.

The CHAIRMAN moved a hearty vote of thanks to Mr. Green, who had shown the great improvements that had been made in some matters, among others in the laying out of foundries. The modern and scientific way was to make the building suit the machinery, instead of, as was generally done in this country, or had been done in the past, make the building suit the land at their disposal, and then when it was erected consider how to place the machinery in it.

Copper and its Alloys in Early Times.

By Prof. William Gowland, Assoc.R.S.M., F.R.S.

The alloys of copper and tin during the early Metal Age, and even somewhat later, were obtained not by melting together copper and metallic tin, but by the reduction of oxidised copper ores containing tin-stone, or of copper ores to which tin-stone was added. As it has been stated by several Continental archæologists that when a copper ore containing tin ore is smelted the tin does not enter into combination with the copper, but passes into the slag, I have made several experiments under the conditions which were available to prehistoric man, which completely disprove their statements.

The copper of the Bronze Age resembles modern blister copper in composition, but, unlike it, it often contains only traces of sulphur. When sulphur is present in the crude metal only in traces it undoubtedly indicates that the metal had been obtained by smelting oxidised ores. The percentage of copper in several characteristic specimens ranges from about 97.0 to 99.0. The following, Nos. 1 and 2, are complete analyses of two specimens from Ireland. No. 3 is one by Dr. Helm of a specimen from Posen :—

	No. 1.	No. 2.	No. 3.
	Per cent.	Per cent.	Per cent.
Copper	96.90	98.95	99.16
Tin	0.08	0.17	0.05
Lead	0.66	trace	0.03
Iron	0.30	0.20	0.08
Nickel	trace	trace	0.02
Arsenic	2.17	trace	0.51
Antimony	nil	nil	—
Silver...	0.21	0.35	—
Sulphur	trace	trace	0.03

From its high percentage of copper and comparative freedom from impurities, except arsenic, the Posen specimen must have been obtained either from a very pure ore or been submitted to a refining process.

As to the earliest alloys of copper and tin, those of the Bronze Age, in the production of these alloys in the earliest part of the Age, copper ores containing cassiterite can alone have been used. A curious feature of the alloys of which the early weapons were made in Hungary is the presence of antimony as an important constituent instead of tin. This doubtless arose from the alloys having been prepared by smelting the antimonial copper ores which occur in that country. A notable example analysed by Dr. Helm had the following composition :—Copper, 91.12 per cent.; antimony, 4.48 per cent.; tin, 0.78 per cent.; nickel, 0.61 per cent.; arsenic, 0.32 per cent.; lead, 1.63 per cent.; silver, 0.45 per cent.; iron, 0.49 per cent.; sulphur, 0.12 per cent. Axes made of these alloys would be fairly serviceable on account of the hardness produced by antimony in copper. We hence find them in use with antimony largely replacing tin, until late in the Bronze Age.

It has been frequently stated that the alloy used by the men of the Bronze Age generally consisted of copper and tin in the proportions of 9 to 1. I have hence compared the analyses which have been published, with the following results :—

Early Weapons and Implements—57 Analyses.

In 25 the tin ranges from about 8 to 11 per cent.
„ 6 „ „ „ 11 „ 13 „
„ 26 „ „ „ 3 „ 8 „

Later. (Palstraves and Socketed Axes) 15 *Analyses.*

In 13 the tin ranges from about 4.3 to 13.1 per cent.
„ 2 „ was about 18.3 per cent.

Spear and Lance Heads.

In 5 the tin ranges from about 11.3 to 15.7 per cent.

Still Later. Swords—33 Analyses.

In 14 the tin ranges from about 8 to 11 per cent.
„ 12 „ „ „ 12 „ 18 „
„ 7 „ is less than 9 per cent.

It is obvious, therefore, that these statements do not accurately represent the facts. And if we consider the different uses to which they were put, it is evident that no single alloy could be equally suitable for all.

Some typical examples of flat bronze axes in the British Museum I have analysed, have the compositions given in the following table :—

Bronze Flat Axes, British Museum.

Locality.	Copper.	Tin.	Lead.	Iron.	Nickel.	Arsenic.	Antimony.	Silver.	Sulphur.
	per cent.	per cent.	per cent.	per c'nt.	per c'nt.	per cent.	per c'nt.	per cent.	
1. Taxley Fen, Huntingdonshire	89 72	8.59	trace	0.16	0.11	0.68	0.15	0.09	Nil
2. Yorkshire (Butterwick)	87.97	10.74	trace	0.10	0 06	0.56	0.15	0.16	—
3. Cambridgeshire	87.41	11.04	trace	1.22	0.11	trace	Nil	trace	—
4. Plumpton Plain, near Lewes ...	86.79	11.34	trace	0.14	0.37	0.78	0.31	0.17	*
5. Near York	85.83	11.73	1.21	0.10	0.14	Nil	Nil	trace	—
6 Ireland ...	86.20	12.52	trace	0.19	Nil	0.68	0.26	0.21	—

* Manganese (trace)

The moulds of the later Bronze Age were either of clay or bronze. In casting swords and daggers of bronze the moulds must have been of clay and been heated to dull redness at the time when the metal was poured in—a method of casting which is still practised in Japan—as by no other means could such perfect castings of their thin blades have been obtained. The castings generally were hammered at the cutting edges, and it is to this hammering, and to it only, that the hardness of the cutting edges of both copper and bronze weapons is due, and not to any method of tempering. Much has been written about the so-called art of tempering bronze, supposed to have been practised by the men of the Bronze Age in the manufacture of their weapons; the hardness is also said to be greater than can be given to bronze at the present day. I should like to correct this error, as it can only have arisen owing to its authors never having made any comparative practical tests of the hardness of bronze.

Among the earliest specimens of the metal which have been found in Greece are some copper nails which were obtained by Dr. Schliemann, at Orchomenos, a city in Bœotia, which was in a state of decay in the time of Homer. They belong to that remote period in Mediterranean civilisation to which the name of Mycenæan has been applied. One of these analysed by Rammelsberg had the following composition :—Copper, 99.53 per cent.; lead, 0.27 per cent.; iron, 0.20 per cent. Bronze was also then in use for nails and cramps in building construction, but especially for weapons, and was of good quality, one of the weapons consisting of copper, 90.76 per cent.;

* Abstract of Presidential Address before the Institute of Metals.

tin, 8.42 per cent.; lead, 0.32 per cent.; iron, 0.54 per cent.

There is abundant evidence to show that Egypt was the first in the field in artistic bronze casting. Even in the early examples great technical skill is displayed. The most ancient Greek bronzes are solid castings, whereas in Egypt they are light and hollow, having been cast with a core of argillaceous sand, which still remains in many specimens.

	Copper, per cent.	Tin, per cent.	Lead, per cent.	Iron, per cent.	Zinc, per cent.	Nickel, per cent.	Antimony, per cent.	Sulphur, per cent.
Ancient statuette with core inside* ...	85.06	2.75	10.89	0.71	—	0.40	0.37	—
Fragment of a great statue† ...	81.22	2.51	16.00	trace	—	0.25	0.02	—
Statuette Osiris (300 to 200 B.C.), with core† ...	76.83	11.23	11.70	trace	—	—	0.13	0.11
Plate from a mummy case (300 to 200 B.C.)†	75.24	13.15	11.40	trace	—	0.21	—	—

* Fellenberg. † Bibra.

Bronze was in extensive use in Nineveh about 1000 B.C. In the British Museum there is a large collection of these objects, which were obtained by Mr. Layard. Several have been analysed by Fellenberg, of which the following are representative :—

	Copper, per cent.	Tin, per cent.	Lead, per cent.	Iron, per cent.	Antimony, per cent.	Arsenic, per cent.	Nick per cent.
Small rod	86.84	12.70	0.28	Trace	—	—	0.18
,, cup	80.84	18.37	0.43	0.16	—	—	0.20

In three other articles analysed by Phillips in Dr. Percy's laboratory the tin ranged from 9.8 to 11.33 per cent. All the above are true copper-tin bronzes with only traces of lead.

The Greek copper alloys of a later period, many examples of which are found in the coins of about the fourth century B.C., are true bronzes consisting of copper and tin, with lead or zinc only as impurities and not intentionally added. A curious feature in them is the presence of nickel varying from traces up to 0.5 per cent. The percentage of tin is somewhat irregular, but in most examples ranges from about 8 to 11 per cent. The same is true of the Macedonian coinage alloys from the third to the second century B.C., but the percentage of tin in them is somewhat greater, generally being from about 10 to 12 per cent.

Unfortunately but few analyses have been made of Greek bronzes. The following are the only representative analyses I can find :—

	Copper, per cent.	Tin, per cent.	Lead, per cent.	Zinc, per cent.	Iron, per cent.	Nickel, per cent.	Sulphur, per cent.
1. Statue in the Art Museum, Dorpat*	88.54	11.46	—	—	—	—	—
2. Statuette†	88.51	10.13	—	—	1.02	0.34	trace
3. ,, †	80.91	10.13	5.25	0.31	—	0.12	,,
4. ,, †	89.96	9.22	—	—	0.44	0.38	—
Fragment of drapery, fifth century B.C.‡	84.49	9.47	5.31	—	trace	—	—
Statue of Dionysus. Græco-Roman period‡	85.05	10.35	4.65	—	trace	—	—
Statue from Ephesus, fourth century B.C.§	89.04	6.09	4.87	—	—	—	—
Vase, 336 to 324 B.C. ‖	81.76	10.90	5.25	—	0.15	Cobalt 1.22	—
Bowl from Roman settlement in Nubia¶	80.81	13.06	5.14	—	0.29	Ni&Co 0.46	—

* Gobel. † Bibra. ‡ Wingham. § Natterer. ‖ Flight. ¶ Gowland.

The earliest Roman alloys which have come down to us are copper-lead-tin alloys of the fifth century B.C. Their chief peculiarity is their very large content of lead, namely, from about 19 to 25 per cent., the tin being about 7 per cent. They were worthless for practical purposes, but formed the alloy of which the large coin of the republic—which weighed from 8 to 11 ozs.—the "As," was cast. One of these analysed by Phillips consisted of :—Copper, 69.69 per cent.; tin, 7.16 per cent.; lead, 21.82 per cent.; iron, 0.47 per cent.; cobalt, 0.57 per cent.; nickel, trace; sulphur, trace.

The copper-tin-lead bronzes appear also to have been used by the Romans for engineering and industrial purposes. An interesting example of this use is afforded by the broken shaft of a water-wheel, which was found in the lower Roman workings of the north lode of the Rio Tinto mine. The water-wheel was probably built in the first century of our era, as coins of the time of Vespasian (70 to 81 A.D) were found near it. The analysis which follows was made by Henry N. Thomson :—Copper, 77.3 per cent.; tin, 9.2 per cent.; lead, 10.5 per cent.; iron, 1.1 per cent.; arsenic, 0.5 per cent.; antimony, trace; silver, 10.2 oz. per ton; gold, 0.2 oz. per ton. The bronze used for statues by the Romans also always contains lead in considerable proportions, as much as 6 to 12 per cent. being often present. In this they were doubtless influenced by Greek practice, the lead being added to the bronze to increase its fusibility and more especially its fluidity when molten, so that it might receive the sharpest possible impressions of the mould. But few analyses have been made of Roman statues. The following are characteristic :—

	Copper, per cent.	Tin, per cent.	Lead, per cent.	Iron, per cent.	Zinc, per cent.	Nickel, per cent.	Antimony, per cent.
Colossal statue* ...	78.33	10.77	10.24	0.14	—	0.52	—
Statuette†	78.77	9.03	12.07	0.13	—	trace	—
,, †	87.36	6.23	6.20	trace	trace	0.21	—
Apollo, Gallo-Roman, first century A.D.‡ ...	80.70	6.44	9.97	trace	trace	—	—

* Fellenberg. † Bibra. ‡ Wingham.

In Roman alloys the percentage of zinc was very variable, ranging from about 11 to 28 per cent. For ornamental purposes and scale armour they had an excellent alloy, of which the following are examples :—

	Brass Rosette, per cent.	Brass Stud, per cent.
Copper	80.42	82.31
Zinc	18.77	17.11
Lead	0.09	0.08
Iron	0.62	0.45
Silver	Trace	Trace
Nickel and Cobalt	Nil	Nil
Tin	Nil	Nil
	99.90	99.95

The Roman brass is one of the most ductile of the whole series of brasses. It is, besides, identical in composition with Tournay's alloy (copper, 82.5 per cent.; zinc, 17.5 per cent.), which, on account of this property and its rich colour, is used for the manufacture of all French jewellery made from thin sheets in imitation of gold.

The following analyses represent selected examples of Roman brass containing the maximum amounts of zinc :—

Analyses of Roman Brass.

Coins.	Copper, per cent.	Tin, per cent.	Zinc, per cent.	Lead, per cent	Iron, per cent.	Antimony per cent.	Arsenic, per cent.	Nickel per cent.
1. Augustus, 30 B.C. to 14 A.D.*	87.05	0.72	11.80	trace	0.43	trace	trace	trace.
2. Tiberius, 41 to 54 A.D.†	72.20	—	27.70	—	—	—	—	—
3. Nero, 54 to 68 A.D.* ...	77.44	0.30	21.50	trace	0.32	0.20	—	0.24
4. Vespasian, 71 A.D.‡	81.97	—	18.68	0.14	0.12	—	—	—
5. Trajan, 98 to 107 A.D.§	77.50	0.30	20.70	—	0.27	—	—	—
6. Sabina, wife of Hadrian, 100 to 137 A.D.§	82.35	0.43	16.84	trace	0.38	trace	trace	trace
Other Objects:— Fibula found at Mayence‖	75.07	0.20	24.45	—	0.28	—	—	—
7. Armlet* ...	82.01	1.79	15.30	0.80	trace	trace	—	0.10
8. Fibula* ...	84.45	1.72	12.31	1.44	0.08	—	—	trace
9. Needle, Ireland¶	84.27	2.36	14.70	—	—	—	—	—

* Bibra. † Gobel. ‡ Phillips. § Tookey. ‖ Fellenberg ¶ Church.

As regards the composition of calamine brass in this country and Europe up to the middle of the seventeenth century, the following examples are given :—

	Copper.	Tin.	Zinc.	Lead.	Iron.	Nickel.	Antimony.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1. Statue at Munich, 1600 A.D.*	76.90	0.64	19.69	2.68	0.17	0.10	—
2. Bas-relief, Germany, beginning of 17th century†	65.34	5.04	25 64	2.09	1.79	0.10	—
3. Memorial brass, England, 14th century .	66.64	trace	23.27	—	0.08	—	—
4. Memorial brass, England, 1456 A.D.‡ ...	67.54	1.16	24.16	7.14	—	—	—
5. Memorial brass, England, 1470 A.D.‡ ...	66.81	2.56	28.50	2.13	—	—	—
6. Memorial brass, England, 1594 A.D. ...	64.00	3.00	29.5	3.50	—	—	—
7. Angel's head, 17th century, Germany†	59.35	1.30	37.03	trace	1.13	0.39	0.20

* Hampe. † Bibra. ‡ Gowland.

Unfortunately, one example alone, No. 3 in the table, is free from an excess of impurities or intentional additions, and with this exception none throw any light on the causes of the superiority attributed to calamine brass as compared with that made by the direct union of the metals copper and zinc.

Attention was recently called to the scarcity of labour in New South Wales, and an interim report by the Royal Commissioner appointed to inquire into the shortage has been presented to the Minister for Labour and Industry. It finds the shortage fully proved, and that there is, in the industries to which the attention of the Commissioner was directed by the evidence placed before him, room for 3,247 more workers. Among the industries mentioned in the report was that of iron-moulding, where a shortage of 60 was noted, and stove-moulders, with a shortage of 20. Sixteen iron-moulders were also required for Government dock work.

"F.T.J." Bookshelf.

The Metallurgy of Steel.

By F. W. Harbord and J. W. Hall. Fourth Edition. London : Chas. Griffin & Company, Exeter Street, Strand, W.C.

The latest and fourth edition of this work has just been issued. Several improvements have been made, one of the most notable of which is the division of the book into two volumes, the first, by Mr. Harbord, dealing with the manufacture and metallurgy of steel and the physical properties of finished steel; whereas the second volume is by Mr. Hall, and deals with the mechanical treatment of steel. The authors and publishers are to be commended upon their enterprise in so often issuing fresh editions of this work. This would not of course, be possible unless there was a considerable sale, but as a result the reader is presented with practically a digest of the current metallurgical literature in the form of a text-book. The trouble with many text-books is that they are frequently out of date by the time they are issued.

Dealing with Mr. Harbord's volume, one of the main features is the number of illustrations. In his 500 pages he introduces 300 illustrations, a procedure much to be commended because it enables descriptions to be shortened, and in most cases drawings convey more than words. After dealing with the Bessemer process, the author treats upon the manufacture of steel in small converters, and as an instance of the close touch with current practice we notice that some space is given to the Stock converter, a comparatively recent invention. Dealing with small converters generally, the author says that with few exceptions, where manufacturers find it necessary to make their steel in comparatively small quantities, small converters are used almost exclusively for steel castings. This, of course, is correct, but the small converter has given very poor results, except where it has been found possible to run the plant day and night, which means a large and continuous output of castings. We believe that except under these circumstances the small converter is a failure, even for steel castings. In a chapter dealing with gas producers Mr. Harbord has been able to introduce descriptions of all the more recent producers, including the Hughes, Kerpely, and Rehmann. A considerable portion of the work is given up to considering the open-hearth process, but it could not be expected that a general work on steel should be so full of any one subject as are special treatises, such as that of Dichmann. Another chapter, which gives the information up to a very recent period, is that dealing with the electric smelting of steel. A great deal has been published in the Press on this subject, and Mr. Harbord summarises the information.

The second volume, for which Mr. Hall is responsible, is equally well illustrated and equally to be commended. It is safe to say that there is no important feature of modern practice, apart from trade secrets so-called, which has been omitted. One excellent feature is a bibliography at the end of each chapter which enables the reader to seek original sources of information. These references will be found invaluable to those who wish to make a special study of any one section, which is, as a rule, the object of the practical man when he consults text-books. One valuable section of Mr. Hall's work is that dealing with forging presses, but practically all departments of the iron trade, such as tube-making, wire-rod rolling, tinning, and galvanising, are dealt with.

Moulding Large Steel Slag Ladles.

In a recent issue of the IRON TRADE REVIEW are published some interesting particulars regarding the moulding of slag ladles by the Prime Steel Company, Milwaukee, U.S.A. This concern is now casting what are believed to be the largest slag ladles ever manufactured. Each ladle is a solid steel casting and weighs 20,000 lb., the dimensions being 10 ft. 5 in. diameter across the top and 8 ft. 6 in. deep, the capacity being 300 cubic feet. With the exception of the rim, the metal at the top is $1\frac{3}{4}$ in. thick, increasing to $2\frac{3}{4}$ in. at the bottom, which is bowl-shaped.

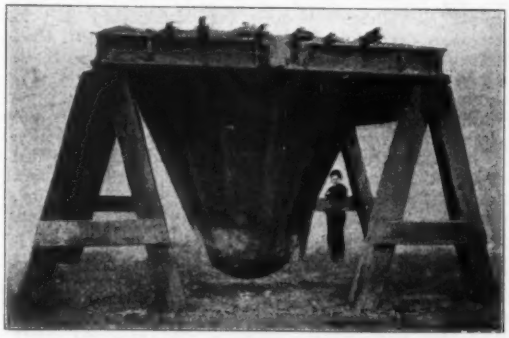

FIG. 1.—COPE WITH CORE ASSEMBLED BEFORE BEING PLACED IN THE MOULD.

The mould is made in a pit, the ladle being cast right side up. The conical core, which forms the inside of the mould, is suspended from the cope. A cross-section of the mould with the core in place is shown in Fig. 3. Fig. 1 shows the cope with the suspending core beneath. In making the mould the sand is first swept out, forming a cavity exactly the size of the *inside* of the ladle, as represented by the line, *a b c*, Fig. 3. The core is then assembled in this cavity and the cope is finished. The cope with the core is then withdrawn, and the mould is swept out again, this time to a size corresponding with the outside of the ladle as indicated by the line, *d e f*, Fig. 3. The cope and core are then replaced and the mould is finished.

FIG. 2.—LADLES AFTER BEING REMOVED FROM MOULDS.

The core, which is one of the most interesting features of the mould, is built up, and consists of 16 separate pieces. Its general construction is indicated in Figs. 1 and 3. Referring to these illustrations it will be noted that it consists of a solid, bowl-shaped bottom piece, *P*, Fig. 3, which is made exactly the shape of the bottom of the ladle, with 15 wedge-shaped slab cores resting on the bottom piece and forming the conical, inside surface of the mould. The whole core is suspended by rods from the cope. Four $1\frac{1}{4}$-in. rods carry the bottom core and each slab core is also provided with three suspension rods, two on the side and one on the top. The slabs are each 7 in. thick and 6 ft. 3 in. wide at the bottom. They are very strongly made, being heavily reinforced with steel rods and are provided with suitable eyes to receive the suspension rods. The bottom piece is also strongly reinforced. Several cast-steel arbors, *A*, Fig. 3, are inserted in the hollow, conical part of the core to resist crushing stresses.

The cope flask from which this core is suspended about 15 ft. square and 18 in. high; it is made of cast steel with steel cross-bars. Its sides are similar in cross-section to a rolled channel. Steel rails are laid across the top of the cope and the washers under the suspension rod nuts rest on these rails, thus distributing the weight of the core. The cope and core together weigh about 20 tons. Great care is taken that the core shall be stiff and able to resist considerable crushing stress, and also the upward pressure of the fluid metal in the mould.

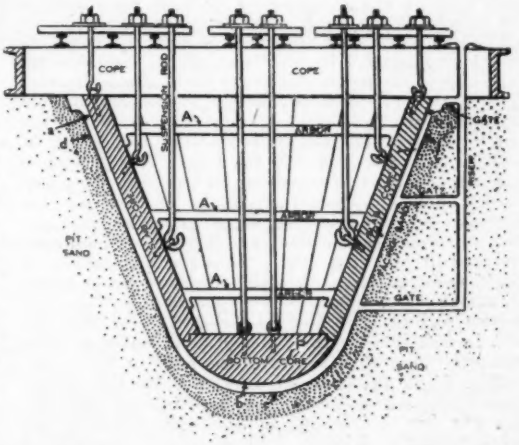

FIG. 3.—CROSS-SECTION OF LADLE MOULD, SHOWING CONSTRUCTION OF THE CORE.

The inside of the mould is skin-dried before the cope is replaced. Only one pouring gate is used, as shown in Fig. 2. It consists of a riser, about 3 in. in diameter, extending vertically into the sand and provided with three feeding gates, one at the top, one about one-third, and one about two-thirds of the distance down the side of the ladle. The gates are about 2 by 4 in. in cross-section. Six small sink heads are spaced equi-distantly around the top of the ladle. The mould is made in the manner described in order to be certain that there shall be no cracks or checks in the finished product.

The metal is poured from a 20-ton ladle and is run into the mould as hot as possible. Ordinary steel is used, melted in an acid, oil-burning, open-hearth furnace. After the casting has cooled it is taken out of the mould by the crane. The gates and heads are cut off, and the interior and exterior of the ladle are smoothed-up with a portable emery grinder.

C

Some Practical Problems of the Foundry.

(*Continued from page* 43.)*

Drop-Bottom versus Solid Bottom Cupolas.

Mr. J. Grant, in opening the discussion on drop-bottom *v.* solid-bottom cupolas, said that after long experience in the use of both kinds he had no hesitation in saying that he considered the drop-bottom was the best form. The advantages he would claim for the drop-bottom cupola were that, in the first place, it made things easier for the men, and enabled work to be very much more quickly done. The speed with which the bottom could be dropped and the slag quenched as against the draw-out method, often saved overtime pay. In this way the drop-bottom was often profitable, besides keeping the men more fit. Again, owing to the speed with which the drop-out could be accomplished and the dump quenched, more coke could be recovered from the rubbish than when the furnace was drawn out. Then, in the case of the draw-out furnace the heat had to be maintained during the draw-out by throwing on small coal. In the case of the drop-bottom this was not necessary, and the expense of the coal was saved. Again, in the case of the draw-out furnace, there was the expense of hooks and the upkeep of them. No hooks were required for the drop-bottom cupola. Another advantage of the drop-bottom cupola was that when it was necessary to examine the inside of the furnace it was much easier to get in. This was an advantage which most foremen and foundry managers would appreciate. In the case of the drop-bottom cupola there was no trouble whatever in getting inside. With regard to the disadvantages of the drop-bottom as against the fixed one, it might be urged that the putting in of the bottom every day was a lot of trouble, but this was not the case. If the bottom was properly fitted, the putting in was very easily and quickly done. Then the danger of melting the bottom would no doubt be urged as a disadvantage. But this occurred so seldom, and was so easily plugged up that it was not worth considering; besides, it would never occur at all with ordinary care. Another argument which might be brought against the drop-bottom and in favour of the fixed one was that the first iron melted on the green bottom was apt to be harder. But this was not the case in the drop-bottom if it was properly worked. He had known cases where a drop-bottom ran hard iron at first, but this was due to the sand in the furnace bottom not being properly dried. For successful working of the drop-bottom a good deal depended on simplicity and lightness in construction. Wrought iron was better than cast iron for the doors, as they could be made so much lighter in wrought iron than in cast. Simple gudgeons and pins were the best for hinges, and a simple wrought-iron prop was better than the most elaborate method of fixing. He had seen a drop-bottom spoiled by being too elaborate. Mr. Grant summed up the advantages of the drop-bottom as follows:—Easier work for the furnacemen; saving of time of drawing out; more coke recovered from the dump, owing to speed of quenching; no fuel required to maintain the heat while drawing out; saving in the expense of providing hooks and maintaining them; easier means of egress and ingress for observation purposes. As to the disadvantages, Mr. Grant added: "I don't think there are any real disadvantages whatever."

Mr. J. J. Howell said he was afraid Mr. Grant had knocked the bottom out of his cupola. Somehow or other he (the speaker) had always looked upon the drop-bottom furnace as a kind of nightmare; with it they were always working with the awful possibility in view of the bottom coming out or the metal coming through the edges and that sort of thing. His experience with drop-bottom furnaces was that they took as long as the solid bottom to draw out, and if anything went wrong with them there was very great trouble indeed; whereas with an ordinary cupola anything that went wrong could be usually put right in a minute or so. The drop-bottom cupola was not so economical. During the Saturday and Sunday the furnace became very cold, they had to put in an entirely new green bottom, and until that was properly heated the furnace could not be worked. In heating this up a greater amount of steam was produced, and this forced its way through the new bottom and they had the iron pouring through the fissures, thus realising the awful possibility of which he had spoken and making a very sad job. He did not think the advantages of the drop-bottom cupola under any circumstances were very great. In fact, he thought that in working one they were at a great disadvantage as compared with the working of a fixed-bottom cupola, where they had only got about one-third of the bottom to renew every day; in the latter they got a sand basis which was a good start for the bottom. With regard to the quickness with which the drop-bottom furnace was emptied, that was more than balanced by the time occupied in putting in a new bottom. He thought Mr. Grant must be a very economical foundryman if the cost of the draw hooks was such a consideration to him. The original cost was not great, and a set ought to last twelve months. With regard to throwing on small coal to keep up the heat in the solid-bottom cupola, he did not recognise the necessity of fuel throwing or raking out. Under ordinary conditions it was quite unusual, as far as his experience went, for it to be necessary to put in coal to assist the furnaceman to rake out his cupola.

Mr. J. H. Toy said that he knew very little about drop-bottom cupolas, but he did know a little about solid-bottom cupolas, and it would take more than the remarks he had heard to induce him to adopt the drop-bottom. The time taken in knocking the front down, raking out and building up again ready for the next morning was well under the half-hour, with two solid-bottom cupolas. He only repaired the cupolas once a week, and, in fact, only let them get cold at the week-end. With the drop-bottom it would be impossible to do this, on account of making the bottom secure each day. No doubt it was very convenient just to draw the bolt and let everything out, if the cupola man wanted to get away; but the unnecessary time and labour had to be spent next day in making the bottom secure again. With a solid bottom he (the speaker) could rake out and make the front up again in two cupolas well under half an hour, without putting on coal or coke.

Mr. Hailstone remarked that he had used drop-bottom and solid-bottom cupolas, and he might say that when once they got a run-out from a drop-bottom cupola they would see to it that another did not occur. It required a great deal of manual labour to stop it. He thought the most frequent cause of run-out with a drop-bottom furnace was that the furnaceman left slag on his bricks. He did not think it was at all due to sand contracting. If the furnaceman left any slag on the bricks before ramming his bottom in, he was

* Discussion before the Birmingham Branch of the British Foundrymen's Association.

bound to get a run-out, because the slag had such a low melting point that when once the iron was molten it melted that slag and found its way to the bottom. If he were putting in another cupola he would have one of the solid bottoms, but it would be of a form named, he believed, the Machiel cupola. That was a solid-bottom cupola, but had a false bottom under the solid bottom forming a receiver for the molten metal. That cupola could be raked out, the larger the size the more quickly. If it took half an hour with that cupola to rake out, and one could save three or four cwts. of coke on the bed each day, that cupola was going to be the best and most economical in the long run. Therefore, it entirely depended upon the conditions under which they worked and the size of the cupola as to whether they used a drop-bottom or a solid bottom.

MR. HEGGIE: It would not be necessary except for a certain class of work to have a receiver.

MR. PEERS: I think a receiver is good for all classes of work.

MR. HOWELL: I think that with a receiver the metal always has a chance of purifying itself. For all grades of metal a solid-bottom furnace is far better than a drop-bottom, and it is better to have a receiver than to rush the metal straight into mould. Even with light mixtures, if you are working from analysis, you work for a certain composition, and if you have a receiver you are better able to keep to the specification.

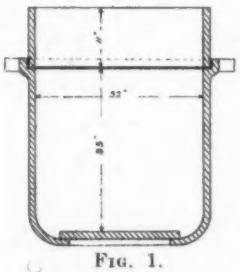

FIG. 1.

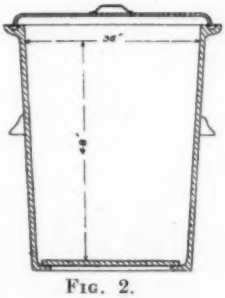

FIG. 2.

MR. HAILSTONE: I agree that a cupola with a receiver is the best. With the ordinary type I have found in a number of cases that when a certain charge of pig-iron is put in the furnace the foundryman does not get the whole charge into the hearth of the furnace. Foundrymen, no doubt, have noticed that down in the hearth of the furnace they do not always get a proper mixture. Nine cupolas out of every ten which will take a 10-cwt. charge, will only hold 7 or 8 cwts. in the hearth of the furnace. If that is the case, a complete charge of the proper mixture cannot be obtained from the mixture of the pigs in the furnace, because to mix that charge thoroughly you must have a receiver for the whole. Therefore, for light work it is most essential that a receiver be on the furnace. For heavy work it does not matter because the metal is mixed in the ladle.

MR. GRANT, in reply, said that one of the principal objections which had been brought against the drop-bottom was the danger of melting out. He would repeat that that danger was very small indeed. He had had a furnace melt out occasionally, but he had never any great difficulty in stopping it. He agreed with Mr. Hailstone that the trouble was always due to the slag. With regard to throwing on coal, he did not know what the practice was in the Birmingham district, but in the North they had mostly fixed bottoms, and coal was always thrown on to maintain the heat. As to half an hour being considered a short time for drawing a furnace, he would have thought that even one of the biggest furnaces might have been drawn out in fifteen minutes; but even fifteen minutes was a long time for a man to endure the heat and strain of drawing out a furnace. He thought it was a good thing if they could save the furnacemen that part of their labour. After a hard day's charging in the case of a big furnace, where 40 or 50 tons were being charged, a man was pretty well tired out, and if he had a solid-bottom furnace he would then have to start the heaviest part of the day's work. It was really a most important thing to save a man the labour of drawing out if it could be done.

Construction of Annealing Pans.

MR. D. DALRYMPLE, who opened this discussion, said that his firm were fairly large makers of cast-iron hollow-ware—saucepans, kettles and pots, round and oval, from 1 pint to 50 and 60 gallons capacity, all of which had to be tinned or enamelled, rendering it necessary to turn or scrape the insides perfectly clean. To enable them to do this they had to anneal all the work so as to make it soft enough for turning. Of course, it might be said that they could use soft iron and so save the annealing. But if they used the iron very soft, they could not get the tin to adhere to it without a great deal of trouble. Again, annealing took away all irregularities and strain from the casting, and so made them last much longer. It was important to make the annealing pans last as long as possible; roughly speaking, they got on an average only 14 heats from the pans before they were burned and twisted out of shape and of

FIG. 3.

FIG. 4.

no further use. They had used several designs of pans, the present one being shown in Fig. 1, made in three parts—body, top ring, and bottom plate. The body part was 33 in. deep by 32 in. internal diameter and 1½ in. thick of metal. The top ring was 11 in. deep, and of the same width and thickness. There was a loose plate in the bottom about 1½ in. clear all round from the edge of the pan. The hole in the bottom of the pan was to allow for easy expansion and contraction when the pans were heated up. The bosses on each side of the pan, which were about 3 in. square and 2½ in. thick, were only used for shifting the pans from the packing room to the oven, and *vice-versa*; the arms of the trolley catching underneath, the pans were levered up and run into and out of the ovens. The pans were packed full of castings, but one had to be very careful with the packing, or the castings would come out all twisted. What was usually done was what they called nesting; that was, packing one inside another. That kept them true to shape after annealing. The packing used was coke dust. Having been packed, the pans were run into the ovens and fired to a temperature of 980 deg. C., and then gradually allowed to cool down, the whole process of heating and cooling occupying about 30 hours. The pans were then taken out and unpacked. It was necessary to cast one annealing pan every day (and sometimes two) to keep up the stock, and this meant a cost of about 55s. to 60s. each pan. The weight of

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these pans complete averaged 14 cwts., so that it was a costly matter, more especially as after the pans had been burnt out of shape they had to be broken up and sold as very rough scrap. He would be very pleased if anyone could say how the durability of the pans could be improved, either by alterations in the design or by any other method. The annealing pans were cast with the same metal as used for the hollow-ware, namely, about equal parts of No. 4 foundry and grey forge.

Mr. F. E. Robinson said that he could not see why one should not be able to get more than 14 heats out of those pans. He had brought with him three sections which might lead up to some discussion. The design shown in the sketch (Fig. 2) was 3 ft. in diameter by 4 ft. deep and 1 in. thick throughout. It was bevelled and not tapered in section. It was made in one piece with loose bottom and lid and with lugs for lifting purposes. The pan was used for annealing hollow-ware iron castings, and had stood a minimum of 200 heats. He had no doubt that this number could have been largely increased if it had not been for the growth of the pans, which was the chief cause of their having to be discarded. The packing of the castings was a most important item. Care should be taken that the articles placed in the pan should not come into contact with the sides of the pan, and an allowance should also be made for expansion during annealing. No material whatever was used for packing. The articles simply had the cover laid over them, and sealed with a sand joint. Fig. 3 showed a design made in four parts, with flanges cast on the full length of each section, and having elongated oblong holes to give free scope for expansion and contraction during the annealing process. He had suggested this section as being suitable for those who had not the means of producing a casting of the requisite size made in one part. Fig. 4 was given as an alternative design to Fig. 2. It was corrugated in section, a form of pan of which he did not believe there were any in use. He had thought it well to suggest this corrugated design, because in his opinion it ought to be one of the strongest sections, and should stand whatever strains were placed upon the pan, whilst in packing they were not so liable to get the articles in close contact with the sides of the pan.

Mr. Hailstone said that the design of an annealing pan depended essentially upon the type of casting to be annealed in it. Mr. Dalrymple had told them that he was using a pan made from No. 4 foundry iron and grey forge iron, and of somewhere about the same composition as that of the casting to be annealed. Now, that pan was raised to a temperature of about 1,000 deg. C., and the metal used for the pan was absolutely unsuitable for work under such conditions to get the best results. The metal contained at least 1 per cent. of phosphorus; it also contained at least about 3 per cent. of silicon, as well as a large amount of graphitic carbon. The moment that pan was heated up to a temperature of from 900 to 1,000 deg. C., the graphitic carbon began to grow, the phosphide of iron became liquid inside the main mass, and by reason of that the pan became distorted. One firm who were using annealing pans employed a certain quantity of their own unannealed scrap, and so much of their own annealed scrap, i.e., scrap from annealed castings (the latter so that the metal should not be too hard or brittle), and also a certain amount of hematite. This mixture gave the best results. He thought that if Mr. Dalrymple would buy some scrap malleable iron, both hard malleable and the annealed malleable, and mix them with a close hematite, the life of the casting would be such as would amply compensate him for the cost of the iron for the mixture in the first case.

Mr. Heggie, in reference to the design of Mr. Dalrymple's pans, did not think any great improvement could be made, though the smaller section at the top might be detrimental, and might cause trouble at the joint. He agreed with Mr. Hailstone that the phosphorus would be too high in the iron referred to. Phosphorus and sulphur should both be low in metal that had to resist great heat, as iron phosphide melted at a considerably lower temperature than cast-iron free from phosphorus. The growth of these pans was the trouble, and iron should be used that had a close grain.

Mr. Bullock said that years ago he was in a foundry where they used wrought iron more than anything else. They found this very necessary for the annealing pans, because they could then knock them into shape again after they had given way.

Mr. Grant said that he had had some experience in annealing the sort of castings mentioned by Mr. Dalrymple, and he was surprised to hear that these pans lasted for only 14 heats. There must surely be something wrong with the casting of the pan, which ought to last very much longer than that. He thought Mr. Dalrymple would do well to try putting in his castings without any packing whatever, and have the lids sealed with a sand joint. He did not think the coke packing was at all necessary to prevent twisting, and to do without it saved so much labour. He had had experience extending over 15 years of annealing hollow-ware castings, but for 10 years they had been working without any packing material. The articles were placed one on top of the other, and if carefully arranged, the expansion did not make any difference. They had very little trouble indeed with regard to twisting. They went weeks and weeks without any twisting, and they used to do 20 tons per week.

Possibilities of the Moulding Machine.

Speaking recently on the subject of moulding machines for automobile castings, Mr. J. J. Wilson, of the Cadillac Motor Car Company, remarked that the impression seemed to prevail that any machine intended for the foundry does not require to be as well built as the one for the machine or pattern shop. Machines in the foundry, he said, were subjected to hard usage, and were constantly exposed to rust and sand or grit to a much greater degree than was the case in any other department. Sufficient attention had not been paid to the protection of all the wearing parts from sand. "If you are going to adopt machines in your foundry start right, make the selection with care and have the best pattern equipment obtainable: iron flasks, well-made taper wood or metal snap flasks, which parts are interchangeable. All pin holes should be drilled accurately with a jig which has been fitted with hardened steel bushings. When the pattern is placed on the machine, after the type of machine most adaptable has been thought out, the kind of pattern material and how it should be made, method of gating, kind of flasks, etc., then we have the complete equipment for making good work, except a man to make the castings. The superintendent, foreman or instructor must furnish the experience for the operator until he becomes proficient." As to the results to be obtained from the judicious use of the moulding machine, Mr. Wilson stated these to be:—(1.) A greater output per man and per pattern. (2.) Castings more uniform and true to pattern, which is essential in automobile castings or any other work where jigs and special tools are used for all the machine operations. (3.) The product at a reduced cost.

A Mechanically Operated Foundry

Plant for Continuous Moulding, Pouring, and Conveying.

The accompanying illustrations relate to the new wheel foundry of Messrs. French & Hecht, Davenport, Iowa, U.S.A., the following particulars of which are taken from a recently published description in the "Iron Age."

The entire plan and details of arrangement and equipment were conceived and worked out in the mechanical department of the Company, and much of the constructional work was done in their own shops. Fig. 1 is a general view of the circular equipment installed by the Webster Manufacturing Company, Tiffin, Ohio.

The building housing the foundry is a two-storey reinforced concrete structure, with nearly all glass sides and a modified monitor roof, the foundry proper being on the second floor, while the spaces for the storage of sand and coke and the tumbling barrels, grinders, etc., are located beneath. The moulding and casting of small work weighing not over 75 lbs. are done on the continuous plan, the mechanical equipment being arranged in completely circular form. Circular conveyors distribute sand to the down-spouts; a circular travelling platform or table, shown in Fig. 1, receives the moulds as they are made and carries them around to the cupolas, where they are poured off, without stopping, from ladles suspended from trolleys on an endless overhead rail. This rail passes around the cupolas and over a portion of the mould-conveying tables.

Passing a few feet farther, the moulds are broken out into a hopper in the floor from which the sand is spouted to the mixing machine below, while the castings are carried away in a chute to the cleaning floor. A view of the mixing machine and the castings chute is given in Fig. 3. The general view, Fig. 1, shows the moulding floor, with the overhead sand conveyors, the spouts to the moulding stands and the circular mould-conveyor platform. Fig. 2 gives a plan of the circles, indicating the method by which the sand conveyors are driven.

The charging floor is of ample area, giving room for storing lining brick, iron, coke, etc. The charges are made up on the lower floor of the building in charging trucks, which are then lifted by the elevators, pushed along on tracks to either cupola, where air hoists, which are clearly shown in front of the cupolas, do the tilting and dump the charges. The blower supplying the blast is located behind and between the cupolas, gates in the tuyere pipes on the foundry floor below regulating the amount of air used.

Sand Mixing and Conveying.

The sand-screening and mixing machine shown in Fig. 3 is located on the ground floor, and the sand which is shaken out from the moulds above is fed into it by the hopper. New sand is added as required, and the mixture is delivered from the machine to the boots of the twin steel-encased elevators, which extend upward 42 ft. to the floor above to feed the inner and outer circular sand conveyors. Gates are provided in the boot spouts, which are operated from the moulding floor so as to regulate the delivery of sand to the elevators.

An electric motor belted to a countershaft drives the elevator, the power being transmitted through bevel gearing at each end of the countershaft to the head gearing. The elevators discharge the sand into conveyors which, as can be seen from the section at AA, Fig. 2, are of the simple drag type with steel-plate flights and a trough of cast-iron. This trough is 14 in. wide and 8 in. deep inside, and is made in 6 ft. sections. The flights are spaced 16 in. apart, and each one is rigidly secured to the $\frac{3}{4}$ by 3-in. bar of steel, which, in sections, end to end, forms the continuous circular member of the moving parts. There is a cross bar with a flanged wheel at each end running on rails formed by angle irons along the upper edges of the trough on each side which supports and carries the moving parts. At this point there is also an outward-facing V-grooved jaw, or cable grip. The circle of these jaws, spaced at intervals of 16 in. all the way around the conveyor, forms a sheave receiving a wire rope by which the conveyor is operated. The outer conveyor has a diameter of 102 ft., measured to the centre of the trough, and the inner one has a diameter of 68 ft.

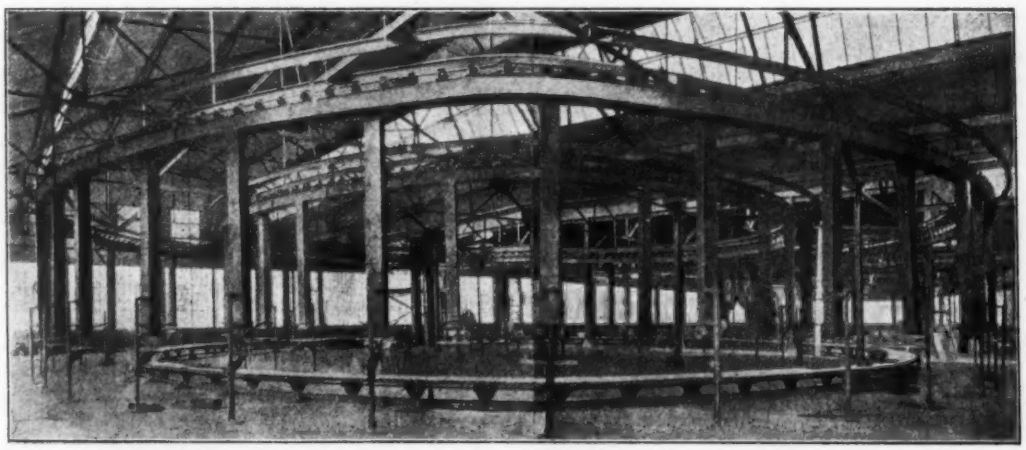


FIG. 1.—GENERAL VIEW OF CONTINUOUS MOULD AND SAND CONVEYOR.

Along that portion of the circle devoted to moulding are located 42 down-spouts to the moulders' stations, 25 from the outer conveyor and 17 from the inner. Each of these spouts is 9 in. square, inside measurement, and has a double undercut discharge gate controlled by a hand-lever at the bottom. The supply of sand is kept slightly in excess of the maximum demands of the moulders so that a little is always carried past the last discharge spouts and around to the tail discharge spouts near the elevators.

The Circular Mould Conveyor.

Nearly, if not quite all, the previous forms of mechanical mould carriers have been of jointed construction with many moving parts. A departure from this practice has been made by French & Hecht in constructing a circular cast-iron table bolted into a practically rigid unit with no working joints whatever. This rigid circle operates on a single track laid on the floor with one file of supporting wheels, as shown in Fig. 1. A motor-driven lineshaft crosses this circle under the floor and is controlled by an attendant at the centre of the circle. At each end of the lineshaft there is a worm-gear connection to the chain drive for the mould conveyor which is thus

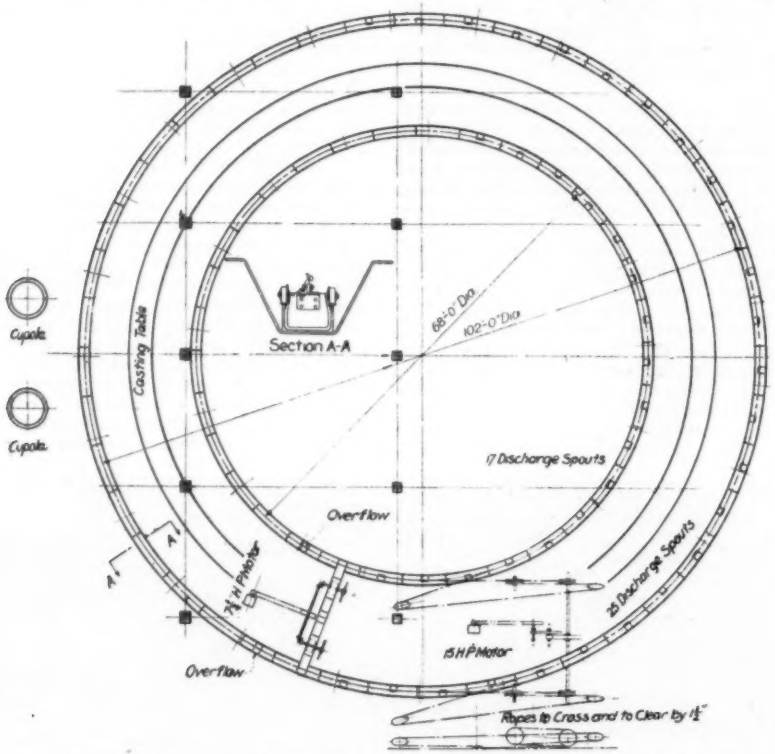


FIG. 2.—PLAN OF CONTINUOUS MOULD AND SAND CONVEYING PLANT.

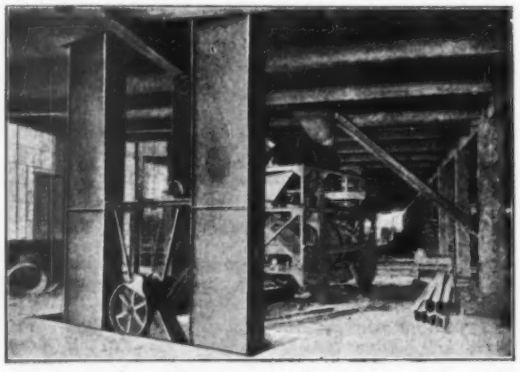


FIG. 3.—CASTINGS CHUTE AND ELEVATORS, WITH SAND MIXER IN BACKGROUND.

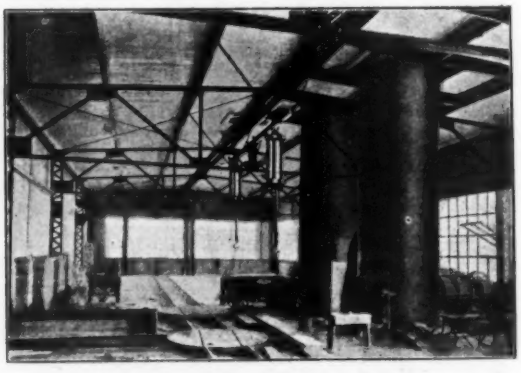


FIG. 4.—VIEW OF CHARGING FLOOR.

By watching the tailings from these spouts the attendant regulates not only the total supply of sand but also its division between the two conveyors.

driven at two diametrically opposite points. From his position in the centre it is possible for the attendant to regulate the speed of the conveyor according to the work of the men pouring off the moulds as they pass the cupolas. The moulders' stations being located both outside and inside the mould conveyor, it is possible to utilise every running foot of the table.

This circular equipment for small work occupies only about half of the second floor. The remainder of the floor space which is located on the other side of the cupolas and is served by them is given over to heavy work, principally machine moulding. A large core room with sand-elevating machinery, also furnished by the Webster Manufacturing Company, is located on this floor as well. The two-storey arrangement of the foundry as a whole permits of the quick removal of sand and castings from the moulding floor to the mixing machinery and the tumbling barrels on the floor below, both descending directly by gravity.

British Foundrymen's Association: Halifax Branch.

Annual Meeting.

The first annual meeting of the Halifax Branch of the British Foundrymen's Association was held on Saturday, January 20. The afternoon was devoted to a discussion on "Foundry Problems," at the Technical School, when Mr. H. Campbell, the president, occupied the chair. A number of technical points were introduced by various members, in the consideration of which much interest was displayed, and the debate proved a very instructive one.

In the evening a dinner and social were held, at which a large company was present. Mr. Hugh Campbell presided, and he was well supported.

The loyal toast having been duly honoured from the chair,

Mr. E. W. Smith proposed the "British Foundrymen's Association," and associated with it the "Halifax and District Branch." His earlier remarks were full of astonishment that considering the importance of the founding industry, and, perhaps, of iron in particular, the Association of which Halifax had now formed a branch had so late a beginning as 1904, and he proceeded to lay stress on the fact that they aimed at furthering the science of the industry, both in a theoretical and practical sense, without regard to commercial relationships between employers and employed. The Halifax and District Branch might be reasonably described as a pretty healthy offspring for a beginning. They started with a large number of members, and upwards of 120, he believed, the figures were at the present time.

Mr. J. E. H. Allbut, of Manchester, the General Hon. Secretary of the parent Association, said, in replying, that the Association was making splendid progress and that their numbers were increasing rapidly. There were 850 members on the books at the present time, and this number would be largely added to by the formation of a Branch at Newcastle-on-Tyne. So they should soon reach four figures. To show the need there was for foundrymen to take every advantage of improving themselves in their art, he dealt at length with the increasing demands which were being made upon their skill and genius, and he pointed out that they had friends innumerable offering scientific papers, which left plenty of room for a number of papers on the practical side, and these were much needed.

The Chairman took advantage of an opportunity to observe that it had been thought that ironfounders did not need educating, and that it was looked upon as an unnecessary thing for them, but anyone who had knowledge and experience of ironfoundry work would be compelled to acknowledge that of all the branches of engineering, ironfounding was the one which demanded the most skill and expert workmanship.

Mr. Frank Berry gave "The Town and Trade of Halifax and District," and in doing so he commented on the fact that the iron trade was becoming a very large factor in the trade of the area covered by the toast. The town was known all over the world, especially for its machine-tools, and he noticed the other day that Leeds was complaining that the machine trade was leaving that town and going to Halifax and other places.

The Chairman, in reply, touched upon the high rates. He was not one of those who liked high rates, but, contrary to some people, he contended that the high rates, whatever might be their effect in some ways, were no bar to the increase of manufactures in the district. The iron and engineering trades up to a year or two ago experienced a couple of years of very trying depression. Families during that period emigrated, and there was an explanation for a certain decrease in the population. It would certainly be an advantage if the rates could be brought down. High rates told most of all on the man who lived in the cottage, and it was on his behalf more than anybody else he should advocate a reduction of the rates. Halifax during the last eighteen months had been doing very well. The engineering trade at the present time was in full prosperity, and he hoped it would continue to be so for some time to come.

"The Visitors" was given by Mr. J. G. Robinson, who expressed the pleasure it was to see so many among them.

Mr. J. H. Whitley, M.P., replied, and after expressing his sympathy with the objects and aims of the Association, said it seemed to him that the foundrymen's trade might be described as the foundation of all things. He supposed that the great bulk of the things which were the pride of their modern civilisation would disappear but for the fact that the trade of the foundrymen was at the base of them all. Things of constructive use and engines of destruction alike, owed their beginnings to the operations of that particular trade. They had, indeed, done well in that town in getting together such a large membership, particularly of the younger members of the trade, to talk over and study the many things which affected them in a scientific aspect.

The toasts were interspersed with musical and other items.

Query.

Skin-Drying of Green-Sand Moulds.

Can any reader give me information regarding the skin-drying of green-sand moulds? I have a great deal of skin-drying to do, and the present method is to kindle a fire in a cast-iron box or chaffer, or on a plate, and let the fire sit over the mould till the mould is sufficiently dried. This method is wasteful, slow and dirty. I have also used drying machines driven by a fan, but these are too large and clumsy for the work in question. I have also used gas, the flame being played all over the surface of the mould from a jet held in the hands of a boy. This also was expensive and slow. I would welcome any suggestions your readers could give me regarding skin-drying.

"A. C. M.," Belfast.

Development of Steel and Iron Founding.

Annual Meeting of British Foundrymen's Association: Sheffield Branch.

The annual meeting of the Sheffield Branch of the British Foundrymen's Association was held at the Literary and Philosophical Society's Rooms, on Tuesday, January 23, Mr. Percy Longmuir, B.Met., President of the Branch, in the Chair.

The Secretary, Mr. R. W. Kemlo, read the Report of the Committee for 1911, which showed that the membership was 97, as compared with 79 twelve months ago. There were also eight new members to be elected which would bring the total to over 100. The year ended with a balance of £9 10s. 10d. in hand. The Committee expressed hearty thanks to the gentlemen who had read papers during the year, but they regretted that the attendance of members was not what the programme justified them in expecting. Three members of the Committee, Messrs. H. Bagnall, W. H. Hatfield and E. Houghton, retired this year according to rule. A new member would also have to be elected in place of the late Mr. W. J. Morris, of Butterley, and the Committee proposed to increase their number from 9 to 12. The Committee added that since the inauguration of the Sheffield branch four years ago all their meetings had been of a serious character. This year they proposed to have an annual dinner.

The President expressed the hope that the proposed dinner would be a success. He referred to the success of the dinners of the Halifax, Manchester and London branches, and he did not see why Sheffield should be behind any of these towns. He also alluded to the fact that the attendance at the various lectures had not been what might have been expected. They could hardly expect the Committee to continue working with the same heart and enthusiasm if they were not properly supported.

The report was adopted.

Election of Officers.

Mr. H. Pilkington moved the re-election of Mr. Percy Longmuir as President of the Branch. He had seen a great deal of the work of their President in that Branch and in the National Council. They had also been associated in the parent Association, both as President, and he knew that Mr. Longmuir would continue to do his very best to promote the success of the Branch.

Mr. J. R. Hyde seconded, remarking that he and Mr. Longmuir were students together at Sheffield Technical School some 11 years ago. He was then pretty well versed in practice and was now well versed in theory; he had an excellent combination of both.

The election was carried unanimously with applause and the President, in acknowledging his appointment, said he greatly appreciated the honour which the members had again conferred upon him.

Mr. W. Oxley proposed and Mr. J. G. Crowther seconded the election of Mr. T. H. Firth as Vice-President.

The President, speaking in support, said he had hoped to see Mr. Firth take the presidential chair; but Mr. Firth was a man who would not take up a position unless he could give the proper time to it, and they hoped he would be in that position twelve months hence.

The resolution was carried.

The President moved the election of Mr. Samuel Osborn as Vice-President. The name of Osborn was one of the best known in Sheffield and they were specially fortunate in securing Mr. Osborn for this position in view of his intimate connection with the steel-casting industry. They would find in him an earnest worker and one who took a real interest in the subjects which came before their Society. When he came to take the chair they would have a man who would encourage the steel side of their work. As they knew the steel side of their work had been much neglected.

Mr. Pilkington seconded, and the proposal was adopted.

Mr. Crowther proposed and Mr. Hatfield seconded the re-election of Mr. Kemlo as Secretary and Treasurer, both gentlemen bearing high tribute to the excellent work done by Mr. Kemlo.

Mr. Redmayne, one of the auditors, supported and referred to the splendid way in which all the books of the Branch were kept, and the President in support said all the work of the position had been well done and nothing had been too much trouble for their Secretary to undertake in the interests of the Branch.

The resolution was carried unanimously.

Mr. Kemlo, in his response, expressed the disappointment he sometimes felt at the small attendance of members at the lectures. He was, however, glad that the work he had done had been appreciated.

Messrs. Crowther and Redmayne were re-elected auditors.

The retiring members of the committee: Messrs. Bagnall, Hatfield and Houghton were again elected, and Mr. Hyde was appointed to take the place of the late Mr. Morris. The Committee were empowered to add three additional members to the committee as occasion required.

The Presidential Address.

Mr. Longmuir then gave his presidential address, the subject being: "The Development of Iron and Steel Founding." He commenced with a brief chat on the work which lay before those who were anxious to enter upon research work. Many remedies had been advanced for faults in founding. At one time it was fluxes, at another chemical analyses and then the use of titanium. He did not disparage any of those; all three were useful and served a purpose. But there were still great difficulties to be overcome and daily new problems presented themselves in the foundry. Moulding alone offered a wide field for research; it could not be said that knowledge on this subject was complete, and he doubted very much whether it would be in their time. Core making and mechanical moulding also needed more study; there was a science in machine moulding just as there was in hand moulding, and it meant a good deal more than sticking a pattern on a pattern plate and putting it on the machine. Next came melting, and if they searched the whole foundry field of Britain they would find plenty of room for study in this department, not merely in finding special fluxes and brands which were used, but also in ascertaining why they were used and what effects were produced. Frequently they were annoyed at the fluctuations which occurred apparently under similar conditions, but it was not sufficient this year to say these fluctuations were there, they must make their best endeavour to discover the reasons for them. Turning next to fuel, and having referred to oil, gas and coal, including coke, he remarked that the electric furnace had come as a new kind of heat producer. Every furnace, particularly those for steel castings, was worthy of close consideration. A short time ago he closely studied several German foundries which were flooding

this country, Sheffield included, with light steel castings, the product of the electric furnace. While for light, intricate steel castings the electric furnace might be used, yet for iron and brass founding it was out of the question. In a good deal of work it was at present too costly.

As an Association they ought also to give more attention to the cost of production. They could not discuss questions of labour or the commercial side of the foundry, but the correct ascertainment of costs represented a subject which was within their scope. As business men they should recognise the value of accurate costing. He knew the Americans carried this to the extreme, professing to work it out to the fifth decimal of a cent. But they need not trouble to work their costs out to the decimal of a penny, though they should at any rate make an effort to get accuracy in the shillings column. He understood there were very few foundries which did that in this country. The points he had raised were common, more or less in both iron and steel practice and they represented directions in which development could very well take place. There were, of course, other points. Iron, for example, grey irons used very largely in certain districts, and particularly in Lancashire, were subject to heat-treatment, which effected a vast improvement in their properties, and rendered them specially suitable for certain work. Here was a field for study; a field which would pay for the time devoted to it. The effect of the heat treatment of malleable iron was universally recognised, and they had an active member of their Association who had done some extremely able work in this matter. But if they took the malleable-iron industry of Britain they could not say that a knowledge of the after treatment was complete in every detail so that every iron founder would know just precisely the best conditions for producing the best results. Here was not only an enormous but a profitable branch for research work. Steel, too, was submitted to after-treatments. Multitudes of papers had been written on the after-treatment of steel; an enormous amount of work had been done of great value, but even all that had been done only touched the fringe of the subject of heat-treatment of steel castings. The field was still a big one with much to be done. When they got to steel a new condition was met which was not found in malleable iron. In the one the conditions could be more or less standardised. Steel castings varied enormously in weight and section, and the treatment suitable for small castings would not apply to the larger ones. The difficulty of reheating large intricate and weighty castings was so great that sometimes more damage than good was done. There was the mass to be taken into consideration. The first thought to the man on the foundry floor was not so much one of temperature as of getting the heat right into the middle of the casting. The question of mass was of vital moment, and it was one which he thought he was right in saying had received very little serious study.

All these points led up to the question of how could they further develope iron and steel founding. The answer of a man like Carlyle would be "More work, more work, and earnest work." There was more research work done in the foundry than in the best equipped laboratory; whether the work was published or not mattered little. The finest research work certainly lay in the study of failures and wasters. Foundrymen, in times past, thought a waster a disgrace. It was certainly a disgrace if the lessons were not learnt and fathomed. It was a disgrace to repeat a mistake time after time without any effort to apply the knowledge gained. In saying failures offered a great field for study, he did not mean microscopic or chemical analysis alone. The man on the moulding floor could, by careful study of his work, gain a knowledge which could not be secured in the finest laboratory, and that knowledge was of real value.

In considering foundry progress as a whole, one had to couple up the work of the scientist, the engineer and the foundryman. Given all three, knowledge of the utmost value would be gained. He concluded by referring to the remarkably good work which the Branch had done, and appealed to members to attend in larger numbers the interesting and instructive lectures given in connection with the Branch.

Coming next to his paper proper, on the development of iron and steel founding, the President remarked that in a lecture given in Sheffield some years ago, on "Iron Foundry Practice," it was shown that, as a rule, the average casting was judged by one, or a combination of the following factors:—(*a*) General appearance and truth to pattern, (*b*) machining, (*c*) the properties of test bars attached to the casting, (*d*) the resistance offered to the circulation of water or steam. Each stage followed in the production of a casting had a very decided effect on one or other of these factors. These stages of production might be described as determining conditions in that they determined the success, or otherwise, of any casting. The determining conditions given in the lecture referred to were (1) composition of charge, (2) the mould and its cores, (3) method of melting, (4) casting temperature, (5) the presence of foreign matter, sand, slag, blow-holes, (6) shrinkage or contraction faults. These six conditions did not, by any means, cover the whole of the stages governing the production of castings, but they served the purpose of drawing attention to some of the more essential features. The composition of the charge and the method of melting it were of very great importance, and were generally recognised. So, too, the method of moulding and core-making had a very distinct effect on the final product, which was recognised in all foundries. There were, however, many little points which did not receive general recognition, and it was these unrecognised items the President examined, omitting the more recognised points of composition and melting. Every foundryman would admit that each new casting constituted a fresh problem, and the greater the amount of trained thought brought to bear on the problem, the greater the amount of success resulting. Every founder would also admit that wasters were produced from time to time. The production of a waster casting was only a disgrace when its lessons were not learned, and the experience gained from it was not utilised. Every waster casting should be regarded as a subject for research or investigation, and if this was followed out the experience gained was of great value. Success was often reached by a study of failures and an application of the lessons they taught. Obviously a waster might be due to the condition of the moulds or to the condition of the metal. In some cases, both mould and metal might be at fault.

Porosity of mould and cores was the chief solution of many defects, so far as the mould was concerned. A porous mould would readily take care of the air displaced by the metal, and the gases generated by casting. A porous mould would not necessarily remove gases contained in the metal before casting, and hence blow-holes were divided into two classes (1) those due to the mould and (2) those due to the metal. Taking the mould first, generally speaking, any source of disturbance which led to bubbling, would result in the trapping of gas bubbles. There was thus some similarity in the source of the blow-hole and that which led to a scab, but in the latter case

the disturbance was sufficiently violent to tear away the sand and thus offer a route for the escape of gas. In both grey iron castings and brass castings, blow-holes when present were in the majority of cases due to the mould and not to the metal. With green sand moulds, a hard or too damp mould was certain to blow, and this applied to the mould as a whole or to parts of it. Local hard spots in the face of a mould led to disturbance, and the resulting blow-holes were due to trapped metal gases, and not to the formation of steam. Local wet spots led to the formation of steam which could not escape and was, therefore, in small quantities, trapped in blow-holes, or, if in large quantities, ejected the metal through the gate. Apart from the condition of the sand, mould or core, blow-holes might originate from the presence of other metals, for example, chaplets in the mould. Any metal forming part of the mould as, for example, chills, spindles, rods, etc., would, unless free from rust and moisture, give rise to blow-holes. Lining shafts was a process limited to the brass foundry, but quite apart from the metal or alloy employed, the metallic core must not only be perfectly dry, but must also be free from rust, which was a chemical combination of oxide of iron with water. Rust or scale, quite apart from preventing metallic contact, would, under certain conditions, give rise to the formation of gas, which, trapped within the metal, resulted in blow-holes. The practice of heating a metallic core or chill was therefore good, and in dry sand moulds nearly always led to success. With a green sand mould, the introduction of a worm core or chill, should be followed quickly by casting, otherwise moisture would condense and blow-holes result. Practically then, blow-holes in grey iron or brass castings were caused in the majority of cases by the formation of steam or the impervious nature of a part or the whole of the mould to the passage of gases generated in the mould during casting. Blow-holes in steel and white-iron castings might be due to the condition of the metal, but it was always well to be certain of the mould before blaming the metal. This could be readily assured by the appearance of the blow-holes themselves, as those due to the mould always showed oxidation tints. Gases absorbed during melting and liberated on solidification gave bright blow-holes free from oxidation tints.

After the mould had been filled, three important stages followed, and these were shrinkage, contraction and warping. Shrinkage and contraction were often confused, but, whilst related, they represented dissimilar processes. Shrinkage referred to the gradual lessening in volume of fluid metal as it approached the solidification point, at which shrinkage ceased and contraction commenced. Contraction, therefore, represented the lessening in length or in volume of the solid material as it fell to the atmospheric temperature. Warping was simply unequal contraction induced by different thicknesses of metal in the casting. It was easy to measure total contraction, but it was not easy to measure liquid shrinkage. Shrinkage had to be met by further supplies of fluid metal until solidification of the casting was complete. This was obtained by means of gates or feeders designed to solidify at a later period than the casting. The art of feeding was one requiring much greater attention than it had received, and systematic study in this direction would lead to profitable results.

On becoming solid, most metals or alloys contracted with a falling temperature. There were exceptions, but these did not oppose the general rule. Contraction was a natural function, and within the limits of the metal used, the more of it that took place the better, for every casting should show its full amount of contraction, otherwise there were certain to be either blow-holes in the metal or stressed products, thus leading to condemnation. Contraction could be met by providing yielding cores, yielding moulds, or by loosening all parts which retarded movement in the casting. In some cases the distortion resulting from contraction was due to the distribution of metal in the casting, and obviously attention to the mould could only partially remedy a defect due to design.

Faults due to the pattern represented an inexhaustible topic, but, in the majority of cases, might be simply expressed as due to a departure from that canon of foundry faith, gradual change in thickness of section. A further aspect of the same question was found in crystallisation, if during cooling conditions were present which affected the crystal growth or caused it to take a particular direction. Such retardation would give rise to planes of weakness if not actual fracture. Faulty design in a pattern showed most in the case of castings subjected to water or steam tests, and it was not sufficiently realised that when under such tests the casting was temporarily extended by the internal pressure, an effect which intensified any local defect.

The ideal casting was one that passed from the liquid to the solid state at a uniform rate in all parts, and one in which solid contraction was fully shown without developing any stresses as the result of contraction or particular routes caused by crystalisation. It was well to note that the balance of the pattern should not be thrown out of gear by the gates. Thus, in the case of a symmetrical casting, the gates, which were part and parcel if it, might be cut in such a fashion as to thus develop contraction stresses in the casting.

Turning to some purely metallurgical aspects, perhaps one of the problems on which information was most urgently required, was that of the influence of oxygen. This influence was largely utilised in many refining processes, and was chiefly illustrated in the case of Bessemer blows and Siemen's steel making. Oxygen, or rather dissolved oxide, was a problem that had to be faced daily in every steel and brass foundry. Oxidised metal did not necessarily imply blown metal, for example, copper castings might be perfectly free from blow holes and yet be saturated with oxide to the point of harshness and dryness. Excess of oxygen in the metal induced red-shortness, a point of little moment to the founder; but at atmospheric temperature excess of oxygen was shown in dry fractures and low elongations. With grey cast irons, owing to the appreciable amounts of silicon and manganese present, the oxide problem during melting was of less moment. In the ordinary cupola the presence of a slightly oxidising atmosphere was shown by the manganese and silicon losses. He (the speaker) had had a really tangible case in which he could definitely attribute abnormal behaviour in the casting as being due to the absorption of oxide during melting. It was worth noting, however, that certain irons had the reputation of being of a stronger nature than others of a similar composition, and observations of this special nature or "body" had been coincident with conditions which favoured the absence of oxide. It was also singular that pig-iron from a rapidly driven furnace did not seem to possess the same body as did similar grades of iron from a normally-worked furnace. If oxygen was present in cast iron, in all probability it was there before the cast iron had been passed through the cupola. The question of oxygen in cast iron was a very open one and called for much further research and investigation.

The relations between copper and oxygen were more fully appreciated than those between iron and oxygen. A characteristic feature lay in the influence of cuprous oxide on the solidification point of copper.

Pure oxygen-free copper solidified at a temperature of 1,084 deg. C., but as the content of oxygen increased the temperature of solidification gradually fell until when 3.5 per cent. of cuprous oxide was reached, the mass solidified at 1,065 deg. C. Further increments of oxygen resulted in the appearance of structurally free cuprous oxide, and the temperature of solidification then rose as the amount of oxide present was further increased.

The more easily handled methods of de-oxidation lay in the use of agents, such as zinc, manganese, etc.; many commercial copper castings contained appreciable quantities of zinc, but smaller quantities could be made to yield solid castings of a copper content reaching to 99.5. The method was, after melting under charcoal, to "flare" the copper, that was to push a small piece of zinc to the bottom of the crucible. The oxygen of the cuprous oxide would pass over to the zinc, and as the temperature of the melting copper was above the boiling point of zinc, the vapour of the zinc coming up through the copper would convey any oxide formed to the surface. The favourite deoxidiser was phosphorus in the form of phosphor-copper containing 15 per cent. phosphorus. An addition of ½ lb. to 50 lbs. copper would give a theoretical phosphorus content of 0.15 per cent. The actual amount of phosphorus remaining in the metal would depend upon the amount of oxygen present in the copper. Manganese and silicon acted in a similar manner to phosphorus, and might be procured in either the ferro or the cupro form, the latter being used for copper and the former for alloys in which an introduction of iron was not a disadvantage.

In the case of nickel, oxide was most tenaciously retained by the metal. When making castings the metal must be de-oxidised before pouring, and the most suitable agent was manganese added as 80 per cent. ferro-manganese. If the iron introduced was objectionable, then mangesium or metallic manganese, such as Goldschmidt metal, should be substituted. Not only must nickel when used alone be de-oxidised, but also when employed as a constituent of alloys, such as German silver and nickel steel.

Of the metal already dealt with—iron, copper, and nickel—the chief feature lay in the fact that they were readily oxidised and the oxides formed remained in the metal, affecting its properties. Metallic tin would unite with oxygen at light temperatures, and would also reduce copper oxide, the resulting oxide of tin being retained by the alloy. On re-melting an alloy containing zinc, a certain amount of zinc was lost, chiefly by volatilisation or boiling off, the vapour burning into oxide when it reached the air. Loss of zinc was a function of the temperature reached and not the amount present in the alloy. This was illustrated in the following instance:—

Alloy.	Highest temperature. Deg. Cent.	Zinc present in the casting. Per cent.	Loss of zinc. Per cent.
Red brass	1,308	10.2	28.6
Yellow brass ...	1,182	25.0	26.1
Gun metal... ...	1,173	1.8	27.7
Muntz metal ...	1,038	40.5	19.0

Given the right composition, correct treatment in melting, with due reference to oxidisation, and a properly formed mould, then one would naturally expect the fullest properties the composition was capable of yielding. The expectation was not always realised, and there were times when, under apparently identical conditions, the properties of the castings varied considerably. For example, five series of tests from five phosphor bronzes of identical analysis gave a maximum stress ranging from 19 to 26 tons, and an elongation varying from 19 to 50 per cent. Examples of this kind led the lecturer to make a detailed study of what he then believed to be the greatest of the unrecognised variables in a well-organised foundry, operated under efficient management and chemical supervision—the factor of casting temperature. To it, many mysterious failures might be attributed. With brasses mysterious failures were chiefly shown under water or steam tests; an apparently perfect casting would leak or sweat under pressure. Such failures were extremely vexing in the case of boiler mountings and similar fittings. Frequently in a series of castings poured from one crucible under apparently identical conditions, one or two would leak while the majority were sound. Attention to casting temperature led to a very considerable reduction in the number of rejections on testing. Some years ago, when conducting experiments on this question, it was observed that the temperature of the melting metal, in the case of chilled castings, had an effect on the depth of the chill, but subsequent experience clearly showed this aspect to be of less importance than that of the effect on mechanical and water resisting properties.

A discussion followed, and at the close Mr. Longmuir was heartily thanked for his address.

Bessemer Memorial.

An interesting ceremony took place at South Kensington, on January 30, when in the new buildings of the Imperial College of Science and Technology, Colonel Sir Charles Allen, on behalf of the Bessemer Memorial Committee, presented the equipment of the Bessemer Laboratory of the Royal School of Mines to the Governing Body of the College, as a memorial to the late Sir Henry Bessemer. The Right Hon. Gerald W. Balfour, P.C., chairman of the Executive Committee of the Governing Body, presided.

THE third annual whist drive and social of the Birmingham Branch of the British Foundrymen's Association was held on Saturday evening, January 13, at the Pitman Hotel, Corporation Street, Birmingham. The company numbered over a hundred, and the arrangements made by the Committee, Messrs. H. L. Reason, D. Dalrymple, C. Heggie, J. Bullock, F. Robertson H. Winterton, and the Hon. Secretary (Mr. George Hailstone), secured a most enjoyable evening. Mr. Winterton acted as M.C. At the conclusion of the whist drive a capital concert programme was carried out under the chairmanship of Mr. H. L. Reason (President of the Branch). Songs were given by Miss H. Morton (contralto), Mr. Williams (tenor), and Mr. Frank Macnamara (baritone), and recitations by Mr. Alexandre Ruvalle, Miss A. M. Corfield (comedienne), and Miss Beatrice Idoine (juvenile comedienne and dancer). During an interval in the concert, the prizes were distributed by the President's daughter.

THE Council of the Institution of Mechanical Engineers notify us that applications for grants under the Bryan Donkin Fund in aid of original research in mechanical engineering should be sent to the Council before October 31, 1912. The second award will be made in February, 1913, and the amount available will be about £34.

THE first meeting of the creditors of W. H. Perrott, trading as W. H. Perrott & Company, iron and steel merchants and agents, 101, Leadenhall Street, London, E.C., was held in London on Wednesday. The debtor returned his unsecured liabilities at £1,366, in addition to which there were partly assured creditors for £6,094, the security held by the creditors being valued at £1,780, and preferential claims at £3 8s. 6d. The only assets disclosed were cash 10s. The estate remained in the hands of the official receiver and trustee.

Works of Messrs. Fraser and Chalmers.

On Saturday, January 13, the London Branch of the British Foundrymen's Association paid the first of a series of visits to works which has been arranged for the present session. Owing to the kindness of the directors of Messrs. Fraser & Chalmers, Limited, that company's works at Erith, Kent, were thrown open to the members, about 40 of whom availed themselves of the opportunity.

The works are situated close to the Thames, on which the company have their own wharf, and practically adjoining the South-Eastern and Chatham Railway, the ground occupied being about 18 acres, nearly half of which is under buildings. Since the works turn out mining and metallurgical machinery of practically every description, the boiler and machine shops are equipped with a very great variety of machines and appliances. Excellent equipment also characterises the foundry, pattern shop, and other departments.

General View of Foundry; Works of Messrs. Fraser & Chalmers, Ltd.

On entering the works, the visitors were met by Mr. Nicol, assistant general manager; Mr. A. Pemberton, works superintendent; Mr. J. W. Horne, chief chemist and metallurgist; Mr. Whiting, foundry foreman; Mr. Bartlett, assistant foundry foreman; and Mr. Scales, pattern storekeeper, who conducted them over the different departments. A visit was first paid to the pattern shop, where a large variety of patterns, from complete and complicated machinery parts to simple sweeps and spindles, were to be seen. Considerable interest was displayed in the way some of the larger patterns were built up. Passing on to the foundry, the visitors had the opportunity of inspecting what is probably the largest iron foundry in the country under one roof. A general view of this department is shown herewith. The building is about 150 feet wide and 360 feet long, with two rows of iron columns supporting the roof, and also carrying several large travelling cranes for handling the metal, moulds, and castings, the latter in many cases weighing several tons. The interest created by this department was increased by reason of the fact that, though the great majority of the castings turned out are for the firm's other departments, the variety of machinery produced from time to time gives the foundry the character of a huge jobbing shop. The repetition work of the ordinary manufacturing concern is scarcely at all in evidence, except in the case of small parts that are constantly being required. In the latter class of work the moulding machine plays a prominent part, while a number of machines are also employed on general castings. Among the numerous refinements which figure in the foundry may be mentioned a small carborundum wheel for cutting and trimming the ends of small cylindrical cores from a rotary core machine after baking. This is only one instance of many in which attention to detail and due consideration to the saving effected by mechanical apparatus have added materially to the efficiency and despatch with which the castings may be produced.

Since engine work enters largely into the output of the foundry, the use of chills for certain parts figures importantly. One corner of the building is devoted to the storage of a large selection of chills

for different work. In connection with these, exhaustive explanations were given by Mr. Bartlett as to their application and effect; while he also added an interesting supplement to the lecture given the previous evening by Dr. Carpenter on "The Growth of Cast Irons after Repeated Heatings." A number of the chills in question were exhibited in various stages of growth, resulting from varying use, and it was explained that the phenomenon has to be strictly watched or it causes trouble in work where accuracy in casting is an essential requirement.

Visiting the cupolas, the larger of which will melt seven tons per hour and the smaller six tons, the visitors noticed a simple "home-made" gauge for measuring the blast pressure supplied to the tuyères, an apparatus which is found to be extremely handy and efficient. The metal used in the foundry is mixed according to the analysis and fracture, which is periodically checked in the laboratory; and it will be readily understood that the varying requirements of the work produced, as regards metal, necessitates the strictest attention to the operation of the cupola. An interesting display was made of a number of specimens of the various pig-irons, speigeleisens, etc., used in the cupolas, the specimens showing the fractures, and labels being attached giving the name of brand, number and analysis; interesting specimens of re-cast pig for special work were also included.

The great number of interesting features to be seen in the foundry encroached somewhat on the time available for visiting the machine and boiler shops; but here again the variety of work in hand was the admiration of the visitors. Many castings from the foundry were to be seen in the course of machining and fitting, giving a still better idea of the excellent quality of work turned out. The production of the different parts for the construction of turbines commanded the interest of many of the visitors, and Mr. Pemberton kindly entered into numerous details of the operations which the parts in question undergo.

After going the round of the works, the visitors were conducted to the offices of the company, which form a separate building, and there in a room which is allotted to the use of the Pupils' Engineering Society, they were entertained to tea. At the conclusion, Mr. J. Oswald, Branch-President, on behalf of the members, tendered appreciation and thanks to the directors of the company for their welcome and hospitality. He commented on the great interest which had been displayed by the members, and on the instructive nature of the visit.

Mr. Holloway, in seconding the proposal, remarked on the generous way in which the whole of the works had been thrown open to the visitors, and the details of the work explained; there had been no reservation, but every one had been at liberty to see what he wished and gather what information he desired.

Mr. Pemberton, in acknowledging the vote of thanks, expressed the pleasure he and his colleagues felt in conducting the visitors, remarking that of the numerous parties who had at times visited the works none had shown such a keen insight into and appreciation of the operations witnessed and the explanations offered.

Mr. J. W. Horne supported the expression of pleasure voiced by Mr. Pemberton, explaining that the firm and the officials alike were earnestly interested in the technical advancement of the foundry and engineering trades.

This concluded what was admitted to be an excellent opening to the programme of visits for the Branch.

Birmingham Electrical Power Station.

On Monday evening, December 11, about fifty members of the Birmingham Branch of the British Foundrymen's Association visited the central generating station of the Birmingham Corporation electric supply, Summer Lane. The visit had been arranged, with the permission of Mr. R. A. Chattock, Chief Engineer and Manager of the Department, by Mr. J. P. Kemp, the Resident Engineer, and the party was received by Mr. G. P. Sutton, shift engineer, who, with his staff, conducted the visitors over the building.

The building at Summer Lane is divided into three bays, namely, engine house, 275 ft. long by 100 ft. wide in one span; boiler house, 275 ft. by 89 ft.; and economiser house, 275 ft. by 47 ft. The workshop block and switch galleries, battery-room and mess-room, etc., are situated at the Summer Lane end. The centrifugal-pump house occupies a position adjoining the canal arm. The attention of the visitors was naturally attracted principally by the arrangements of the engine-house. The engines already erected or in course of construction comprise six "Belliss" engines, of approximately 3,000 h.p., operating 1,500/1,875-kw. direct-current generators by Messrs. Dick, Kerr & Company; five "Belliss" engines of the same dimensions operating A.C. generators of the same capacity by the British Westinghouse Company; three "Belliss" engines of 1,000 h.p., operating 500/625-kw. British Westinghouse alternators, with the necessary condensing plant. In addition, there are two 180-h.p. "Belliss" engines, working dynamos for exciting purposes, supplied by the General Electric Company. The eleven large engines for operating the 1,500-kw. units are of the "Belliss" self-lubricating type, having an output of 2,140 to 2,680-b.h.p., the cylinder dimensions being 25 in., 36½ in., and 55 in., by 33 in. stroke. To two of the large A.C. engines, Belliss & Morcom's exhaust turbines have recently been added, giving, in each case, an addition of over 66 per cent. to the power developed without calling for any additional floor or boiler space. These turbines will gradually be applied to the whole of the generators, thus providing, without extension of the building, an addition of two-thirds to the originally-designed capacity.

The engine house is furnished with a large overhead electrically-driven Appleby four-motor crane, capable of lifting 40 tons on one lift and 10 tons on the second lift. The crane has a span of 97½ ft. The works are laid out for an ultimate capacity (which will be very shortly attained) of 29 water-tube boilers fed by six feed pumps each of 8,000 gallons per hour capacity, and four electrical pumps each of 20,000 gallons per hour capacity. The boilers are of Babcock & Wilcox's well-known "Land" pattern. For seventeen of the boilers the stoking is by Babcock & Wilcox's double mechanical chain-grate stoker.

The coal-handling plant is one of the features of the station, while among other equipment on this side of the premises were noticeable the cooling towers. These, of which there will ultimately be twelve, are designed to supplement the canal as a cooling medium for the circulating water and operate by natural draft. They have been constructed entirely of steel by the Wellington Pump Company, Limited. Each will reduce 125,000 gallons of water per hour, 30 deg. F. under average atmospheric conditions.

At the conclusion of the visit the party assembled near the entrance, and Mr. H. L. Reason, as President of the Branch, proposed a vote of thanks to the engineers and their assistants for the facilities which had been given.

British Foundrymen's Association.

Lancashire Branch.

The fourth annual dinner of this Branch took place at the Victoria Hotel, Manchester, on Saturday, January 13. Mr. F. Pennington, President of the Branch, presided over a large company, and among the visitors were Mr. E. L. Rhead, M.Sc.Tech., and Mr. Allbut, the General Secretary of the Association.

The toast of "The King" having been honoured, Mr. W. Russell proposed "The British Foundrymen's Association and the Lancashire Branch." He was gratified, he said, to see among them some of those who were present at the meeting when the Association was founded.

Mr. W. H. Sherburn, M.R.S.A., in responding, remarked that although the Lancashire Branch had only been in existence a short time, it had amply justified its formation, and that in three ways. Many foundrymen used to think they were an inferior sort of beings compared with engineers and other fellow-craftsmen, who had periodicals and societies representing them and their callings. Now one result of the founding of the Association had been that there was a better feeling among all these various classes. The second good result they owed to the Association was the education of the members, who were much better informed than formerly concerning the practical and technical difficulties of their work, and were much nearer the solution of some problems than they were even five years ago. (Hear, hear.) Then the third reason for which he was proud of the Associationwas the near connection and closer intimacy it had promoted between science on the one hand and the foundry on the other. Although the Lancashire Branch was only a few years old, they had already got a very vigorous baby, nearly as big as its mother—(laughter)—in the Halifax Branch, for which they heartily wished the greatest success. (Applause.)

Mr. E. L. Rhead gave "The Trade and Commerce of Lancashire." In the time, he said, when our forefathers fished in the rivers and meres, and hunted in the woods for their food, Lancashire was a thinly populated county, whereas now it was a teeming and busy hive of industry, the pulse of which was heard all over the world. Wherever men were to be found, Lancashire goods were to be met with. This had been brought about by the intelligence and enterprise of men who were second to none in the Empire, men who had ever striven to do their best under all circumstances, to produce articles and goods of utility to the community, and to distribute them in the best possible manner. They as workers in iron could feel that they had played no small part in bringing about the position which the country held to-day. Handicraft, he continued, was the beginning of all effort in production, but power was the means by which production could be increased. Development of power had always been closely associated with iron, and iron was king, whether looked at from a commercial or from an industrial standpoint. Iron weapons conquered those of stone and bronze, and iron machinery and engines had developed the power that was at the root of the successful prosecution of Lancashire industries, and the secret of her extensive commerce. (Hear, hear.) In the olden times small forges were to be found nestling in the vales of Lancashire, and located on the bleak hillside, where the ore was smelted and made into implements both for war and for use in agriculture. Here and there from time to time heaps of slag, ruins of old furnaces, unfinished or decayed weapons, and small hoops of rusty chain mail bore witness to the activities of that day—a day when might perhaps was looked upon as right, and when the inhabitants of Lancashire were concerned with the chase and with warlike pursuits. In nearer days they had the steam hammer of Nasmyth, the Whitworth guns, the engines and machines of Galloway and other famous makers to keep them in the forefront which the county had so long occupied. At the present time the engineering activities were at the fullest stretch in every field, maintaining the reputation of Lancashire in that respect. In another direction they had cotton machinery and looms, which owed their importance to iron, and they as ministers of this king must always be on the alert to do their best to interpret his decrees in such a manner that the subjects whom he ruled would never have reason to be ashamed of his dominion. Foundry practice, which had done much to maintain that dominion, and much to extend it, should be kept at the highest possible level, and in toasting the industries and commerce of Lancashire they were in no small measure toasting themselves. Let them look to it that there should be no flaw in the argument, that those who used their products should never have reason to blow upon them for defects. They must always be prepared to crystallise the ideas into the requirements of the time, and they would be able to do that only by conscientiously carrying out in the best possible manner every duty that fell to their lot, whether in the practical work of the foundry, in imparting instruction in the principles that underlay the successful manufacture of iron castings, or in applying them to the uses for which they were intended. (Applause.)

Mr. R. W. Kenyon in replying to the toast, said they had often heard quoted the saying of a well-known statesman—"What Lancashire thinks to-day, England thinks to-morrow"—and whether that were true or not in regard to politics, he certainly believed it was true in regard to matters of trade and commerce. The county owed some of its success to the variety of its industries, many of which he enumerated, for the more varied the industries the greater was the prosperity likely to attend upon the efforts of those engaged in them.

The Chairman, in submitting the "Halifax Branch," said he was happy to say it was now over a hundred strong in members, and there were others waiting to join. They transferred to it some 12 or 14 of their own members from the Lancashire Branch, but the loss had already been made up.

Mr. Allbut, general secretary of the Association, responded. He observed that previous to the founding of the Halifax Branch, the local Technical Education Committee had started a foundry class at the Municipal Technical College, in addition to which the promoters had the benefit of the experience of the Lancashire Branch. He had great pleasure in informing them that the Association was still growing, and in the course of next month they were going to form a Branch at Newcastle-on-Tyne, which they hoped to begin with at least 100 members. He trusted that as many members as could possibly do so would attend the next Annual Conference, and mentioned that it was the intention of the Council, as the number of members increased in the near future, to set on foot some research work in connection with foundry practice. He appealed to the members to do their utmost to bring in recruits to their respective Branches.

The other toasts were "The Visitors" and "The Press."

A programme of songs and recitations added considerably to the enjoyment of a very pleasant evening.

Correspondence.

Casting Temperatures in Cast Iron.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The theory is often put forward that with large castings the higher the temperature at which the metal is poured, the more solid will the casting be. It has always been the writer's contention that the temperature at which the moulds are poured should depend on the size, shape and thickness of the particular casting being made, and also the composition of the mixture employed. The metal should be melted as hot and as quickly as possible, whatever the mixture, and to get the best results the moulds should be poured so that the metal will be perfectly fluid when the mould is full. This not only gives a sharp outline, but the occluded gases have a better chance of escaping, and also the feeding where necessary can be performed with more satisfactory results.

The idea of pouring large castings at very hot temperatures does not appear to be a good one, according to my own experience—meaning by very hot temperatures, as hot as it is possible to get the metal from the cupola—and I have never seen this theory practised with regard to large castings. Pouring at hot temperatures must necessarily increase the shrinkage in all cases. Since all irons increase in bulk when in a molten condition, the higher the temperature the greater the shrinkage when coming down to atmospheric conditions.

Casting with metal at hot temperatures will raise the heat of the moulds, in addition to the metal being hotter, and retard the cooling down of the casting. The more the cooling down is retarded, the greater is the segregation of phosphide of iron and sulphide of iron, these impurities tending to destroy the homogeneity of the castings and to form cavities. If it were not for this segregation, which follows more or less in all castings when the cooling is prolonged, it seems possible to the writer that a higher percentage of phosphorus could be used with good advantage.

The unsuitability of the mixtures employed plays a far more important part in the quality of the castings than the temperature at which they are poured. Apart from the segregation of phosphides, sulphides, etc., the graphitic carbon has a weakening effect if of a coarse or flaky structure, and the best and densest castings are those that have the graphitic carbon in as fine a state of division as possible. How can this fine state of division be attained if very hot temperatures are used when pouring? The cooling takes longer and helps forward the growth of plates of graphitic carbon. It is possible to hasten the cooling in some cases, but when the castings are large and of intricate design, it is not good practice to disturb them for days.

Another very important point to be considered is the practice of using several brands of pig-iron. These may possibly have varying degrees of fusibility, and to get anything like good results they should be blended or run down once before the final melting, which is now often practised in foundries where high-class work has to be turned out. This variation in degree of fusibility would probably give a poor quality of casting under ordinary casting temperatures, but to pour a mould with metal of such a composition at a very hot temperature would end in the casting being a complete failure, by reason of the unequal shrinkage. Therefore, the theory of pouring moulds of all classes with metal at hot temperature does not appear to me reasonable or likely to give anything like the results that would be obtained where judgment is combined with a good knowledge of constituents.

The effect of pouring the mould with very hot metal in the case of a large section, involves subjecting the projecting parts to an increased strain, and causing extra erosion, scabs and rough faces on the castings. The placing of runners and the areas of same, contribute a fair share towards success. With green-sand moulds, the metal is required hotter than with dry-sand moulds, on account of the cooling action of the mould.

In the case of a large square casting, when cooling down it is probable that, in addition to the ill-effects of segregation, the sides will be apt to cave in, because the angles will be cooling from two distinct points, and the sides from only one. The longer the metal is in solidifying the more pronounced will be the caving, and it is therefore evident that with metal poured at higher or lower than the proper temperature, the castings will be weak, and as no fixed temperatures can be laid down it is experience and not the pouring of the metal as hot as possible which is most reliable.

Yours, etc.,

J. PEERS.

Chilled Castings.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The complaint of your correspondent "Flux-Midlands" and the reply you give to same has interested me. Your correspondent, unfortunately, does not give particulars of his cupola, but perhaps that matters little, since he is himself satisfied that it is working well, and in addition he gets no thick metal. Surely if anything were wrong with either the iron he is using, with the coke, or with the blast, all the iron in the cupola would be affected, and not simply the first five cwts. or so. I have on several occasions met with the difficulty mentioned, and each time I have applied the remedy which I am now going to suggest to him, viz.: to make the ladle hot. Up to the present I have found that this remedy, simple as it seems, has proved efficacious.

Time after time have I noticed that a first ladle-full of iron has, when poured, given slight chills in thin parts of castings and in places similar to the parts affected in your correspondent's castings; whilst subsequent pourings from the same ladle and out of the same cupola, have given no trace of a chill, thus proving that the ladle was not hot enough in the first instance, and thus chilled the iron before it was poured.

You suggest, in your reply, the use of a softener. I know nothing of the "softener" you suggest, not even its analysis, but I presume it is a high silicon pig, with about 3.25 per cent. to 4 or 5 per cent. Si. (known as "Silky"), and if I am correct in my surmise, I strongly urge "Flux" to refrain from using such an iron. It may be all right for common work where no strain has to be stood and no strength is required, and where it is necessary to use up large quantities of scrap, but for such work as cogged wheels or for machinery castings of any kind, I should certainly not like to use such material. One quite understands that such a pig is "toolable," it ought to be so, as it also would be extremely weak.

No, Sir, "Flux" does not want softeners, what he wants is to see that his ladles are quite hot, then I fancy he will not have cause for complaint of chilling.

Yours, etc.,

GEO. H. FOSTON,

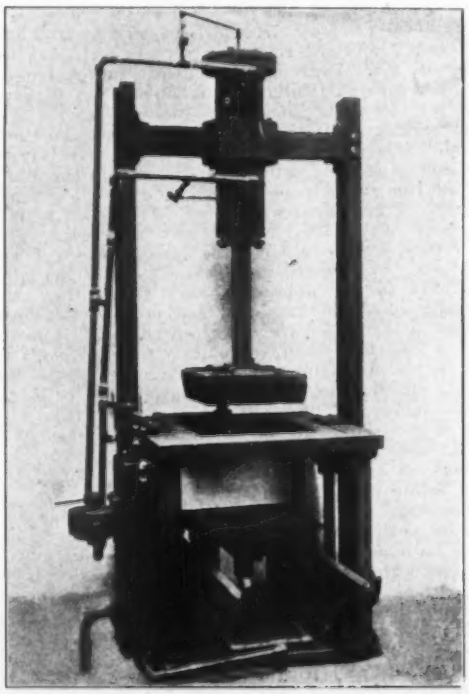
Stechford, Birmingham.

Foundry Plant and Equipment.

The "Manchester" Moulding Machine.

The moulding machine shown in the accompanying illustration is operated by compressed air, and is said to afford considerable economy of air consumption. The machine will work effectively with 25 lbs. per square inch pressure, but is strong enough to work with pressures up to 100 lbs. In volume the economy is equally marked, as ordinary ramming is effected by the gravity of the weight of the rammer head, piston, and rod, this latter having been increased in diameter so as to give additional weight, also to minimise the space to be filled with compressed air for raising the hammer head.

As will be seen from the illustration, which depicts one of the experimental machines, the ramming is from above, and it is claimed that exceedingly hard or soft ramming, or any intermediate condition can be got, as the machine is under the absolute control of the operator, without complicated adjustments. The variation in ramming is effected by



THE "MANCHESTER" PNEUMATIC MOULDING MACHINE.

means of a three-way cock placed on the supply pipe leading to the top of ramming cylinder. For ordinary ramming this cock is open to the atmosphere and closed to compressed air, but when harder ramming is required the cock is opened to admit compressed air to the top of the cylinder.

An improved type of vertical double-acting vibrator is fitted to the machine, and as it operates in the direction of the turn-over table the full force is delivered to the pattern plate. A double-ported plug valve, with special provisions for taking up the air, controls the air supply to the ramming cylinder, and a new pattern of oil governor controls the mould-drawing arrangement. This oil governor is positive in its action; when the valve is closed the drawing table is locked, and when open the motion is easy, even, and free from pumping. When the load is on the governor, the pressure is on the "U" leather only, and not on the gland packing.

Steam piping is used for the pressure pipes, as these are considered by the designer to be a great improvement on the rubber tubing generally used with pneumatic machines. A further feature is that there are no springs whatever on the machine, air cushions being provided where necessary. The table of the machine can be made to fit existing pattern plates and boxes.

The apparatus above described is the invention (patented) of Mr .Edward Oakes, of Manchester, and the sole makers are Messrs. Omerod Bros., Hebden Bridge.

Cyclone Oxy-Acetylene Apparatus for Autogenous Welding.

The autogenous welding process illustrated herewith involves the use of a cyclone acetylene generator consisting of a cylindrical tank (Fig. 1) which forms the

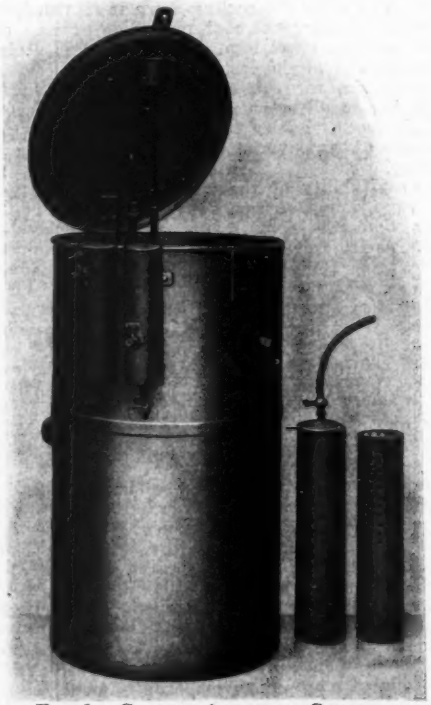


FIG. 1.—CYCLONE ACETYLENE GENERATOR.

outer casing containing water to a defined level. In its centre is another vertical cylinder of smaller diameter which forms a reservoir for the acetylene. In-

side this reservoir are a number of still smaller diameter vertical cylinders, which contain calcium carbide, from which the acetylene is generated by contact with the water from the outer tank. Each carbide cylinder is provided with a tap, and a corresponding tap for each cylinder on the reservoir. Each pair of taps is

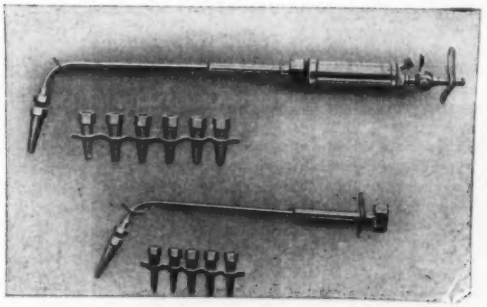


FIG. 2.—CYCLONE BLOW PIPE AND NOZZLES.

connected with rubber tubing. From the reservoir the gas is led to a hydraulic valve, attached to the outside of the outer tank, and thence to a drier which abstracts the water, and from there to the blow pipe.

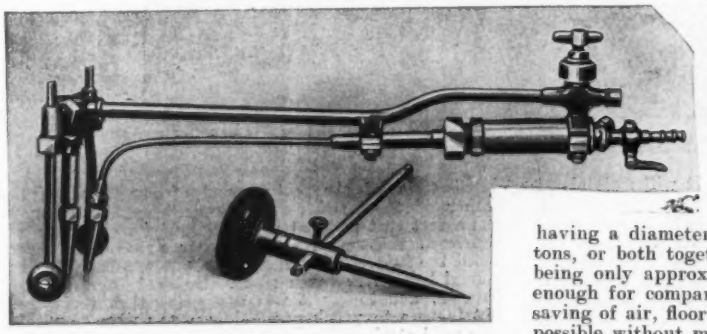


FIG. 3.—THE CYCLONE TWIN-JET, OXY-ACETYLENE CUTTER.

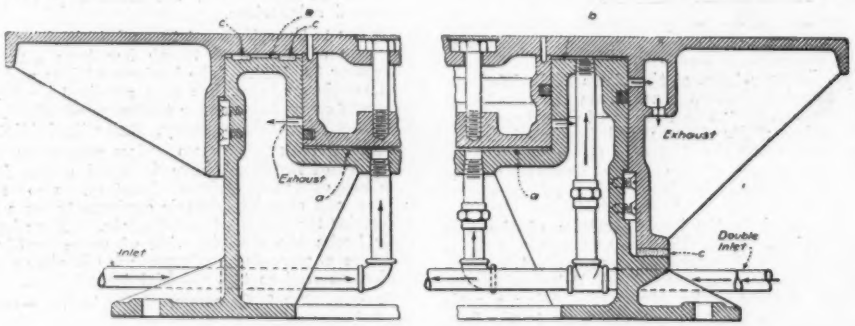
Oxygen is the other gas used in this process. Automatic regulators are fitted to these cylinders, provided with gauges indicating the initial pressure in the cylinder, and the leaving pressure from the regulator.

such a size and form as to be easily handled by the operator. By a special attachment to the blow pipe, or by the use of a separate instrument, metals can be cut in a very expeditious manner. This is done by a separate jet of oxygen directed on to the metal to be cut after heating by the welding jet (Fig. 3). The two jets are arranged either close together as twin jets, or may be concentric, the oxygen being in the centre and piercing the welding flame which is used for heating the metal.

The makers of this apparatus are Messrs. Matthews and Yates, Ltd., Cyclone Works, Swinton, Manchester.

A Duplex Jarring Moulding Machine.

The accompanying drawing shows a simple type of valveless jarring moulding machine, built by Mr. J. A. Murphy, Hamilton, Ohio. Machines of this type are built with either single or multiple cylinders. Where economy is a matter of great importance, a simple cut-off valve, not shown, is bolted to the base and operated automatically by an adjustable tappet attached to the side of the table slide. With some slight changes of design the machine can be equipped with a variable stroke valve, which will vary the stroke of either one or both cylinders from $\frac{1}{4}$ to 3 in. In either case either cylinder can be operated separately or in combination with the others, as the operator desires to handle various amounts of load. In this way the machine finds a general application where the work handled is of varying weights and sizes. For example, the cylinder *a* has a diameter of 12 in., and with an air pressure of 80 lbs., will lift two tons. The other cylinder, *b*, having a diameter of 20 in. less 12 in., will lift four tons, or both together will lift six tons, these figures being only approximate, but at the same time close enough for comparative values. In this way a great saving of air, floor space and extra machinery is made possible without materially increasing the cost of the machinery installed. Where only one cylinder is required, the table slide can be shortened and the jar taken on the two fibre rings *c*, fastened in the cylinder *b*.



THE MURPHY DUPLEX JARRING MOULDING MACHINE.

The cyclone blow pipe (Fig. 2) is the actual welding instrument. It weighs less than one pound and is of

THE partnership heretofore subsisting between Messrs. M. A. Sheldon and H. E. Sheldon, carrying on business as metal dealers, at 26 & 27, Augusta Street, Birmingham, under the style of W. Hy. Sheldon, has been dissolved.

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The Helberger Electric Furnace.

In our last issue we gave an illustrated description of the Helberger electric furnace, designed more especially for use with non-ferrous metals. As supplementing the details contained in our article we illustrate herewith the latest and smallest type of this furnace, which should prove a useful appliance to metal refiners, and in the testing laboratory. The design ,as will be seen, is ingenious, embodying an ideal shape for a crucible furnace. It will melt about 100 grammes of silver or gold in a few minutes, and even platinum may be easily and cleanly melted. The metal is poured directly from the furnace into the mould. We understand that although only recently brought upon the market, several of these little furnaces have already been disposed of, and are working satisfactorily.

A Small Helberger Electric Furnace.

The largest size of the Helberger furnace so far constructed, will melt 5 cwts. of steel or 10 cwts. of copper, and is claimed to be the most efficient furnace of its kind for these purposes.

For these additional particulars we are indebted to Mr. J. Härden, 6, Downs Road, Luton, Beds., who has acquired the agency in England for this furnace.

Notes.

On Monday, January 29th, at the Town Hall, Wednesbury, an illustrated lecture was given by Professor H. C. H. Carpenter, on "The Growth of Cast Iron after Repeated Heatings: Its Causes and Suggested Remedies." The lecture was the first of a series which is to be given in the towns of the Black Country at the instance of the Staffordshire Iron and Steel Institute. Invitations had been sent out to manufacturers, students and others interested in the iron industries of the district. Mr. Isaac E. Lester (President of the Institute) was in the chair, but the meeting was opened by the Mayor of Wednesbury (Alderman A. E. Pritchard), who wore his chain of office. The Mayor, in giving a welcome to the Institute, referred with pleasure to the fact that Mr. Macfarlane, who had moved the resolution out of which that visit had resulted, was a Wednesbury man, as was also the President of the Institute (Mr. Lester), whose family had been for a century associated with the iron and steel industries of that district. The industries of Wednesbury had done a great deal for the country. He might instance Mr. Cornelius Whitburn, who initiated the now world-wide industry of tube-making, and the Rev. Mr. Hardy, who introduced the manufacture of axles. It was also interesting to know that Professor Carpenter was a descendant of Richard Cort, who patented the puddling of iron, although, like many other geniuses, he did not reap the reward of his labours.

Professor Carpenter thanked the Mayor for his graceful reference to his (Dr. Carpenter's) ancestry. He was, in fact, the great-great-grandson of Richard Cort, of whom "The Times," at his death, said: "He is the Tubal Cain of the century and of our country; the Father of the British Iron Trade." (Applause.) It was a fact that puddled iron still held its own. He remembered that when the Bessemer process was introduced the funeral of puddled iron was predicted. That funeral had never taken place. Puddled iron still held its own, and to-day it was recognised that there were certain uses to which puddled iron was more applicable than mild steel.

Sir W. G. Armstrong, Whitworth & Company, Limited, of Elswick, are to build two oil-carrying vessels for a London firm.

Vickers, Limited, have been awarded an order by the Brazilian Government for three river gunboats, 250 ft. long, and mounted with quick-firing and other guns suitable for this class of craft. The company have also received an order from the Admiralty to build three improved submarines.

Owing to the retirement through ill-health of Mr. Smith the firm of Ferrier & Smith has been dissolved as at December 30, 1911. The business of iron and brassfounders, engineers, etc., has been acquired by Mr. Ferrier, who will carry it on under the name of W. N. Ferrier & Company, Penicuik Foundry, Penicuik, Midlothian.

The Phœnix Dynamo Manufacturing Company, Limited, of Bradford, have in hand orders for a large number of motor-driven boosters, also alternators, motors, and complete electric equipments for a number of industries throughout Great Britain. They have also on their books the electrification of seven textile factories and several screening equipments for English colliery companies, as well as two Colonial installations.

Yeadon, Son & Company, of Leeds, have recently forwarded one of their complete briquette plants to the Namaqua Copper Company, Limited, South Africa. This is for the purpose of converting their small copper ore into briquettes suitable for smelting purposes. A member of Messrs. Yeadon's firm has gone out to Namaqualand to superintend the erection, and to start the working of this plant.

Inventions.

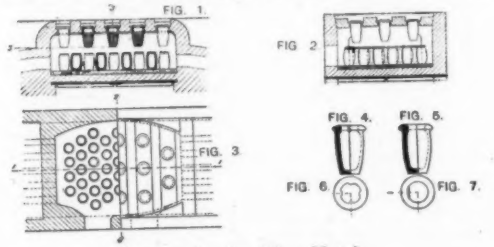
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

215. *Manufacture of metallic tubes. C. T. B. Sangster.
279. Sand-hopper for moulding machines. S. Barnes.
280. Sand mixers and coolers. S. Barnes.
281. Automatic moulding sand riddles. S. Barnes.
282. *Cupolas. S. Barnes.
550. *Portable furnaces. M. Davis.
1,065. Process for refining metals and metallic alloys. T. Turner.
1,081. Manufacture of metal castings. W. G. Bungeroth.
1,293. Manufacture of silicon steels. C. P. Williams and Brymbo Steel Company, Limited.
1,346. Casting alloys. F. de Buigné.
1,384.*Ingot moulds. E. Evans.
1,667. Process of and apparatus for making moulds for castings. F. W. H. Shepherd.
27,724, 27,725 and 27,726. Moulding machines. A. P. Smith, trading as Britannia Foundry Company.
28,567.*Crucible-furnaces. H. Koch.
28,694. Gas-fired hardening-furnace with self-contained draft and special burners. E. O. Rothman.
28,700.*Gas burners for working metals. Continental-Licht-Apparatebau Ges.m.b.H.
29,071. Protection of metal castings. Thomas Holcroft & Sons, Limited, and A. Holcroft.
29,112 & 29,113.*Die-casting machine. (Indiana Die-Casting Development Company, United States.)
29,126.*Electric furnace. A. Helfenstein.
29,180.*Composition for use in casting for constructing moulds, cores, etc. J. W. Bainbridge.
29,223. Apparatus for regulating the temperature of molten metal. L. W. Sterne.
29,239. Sand-moulding machines. S. Strettles.
29,348.*Pouring gates for moulds. W. Mills and H. Joyce.
29,355.*Furnaces. R. Okrasa.

Abstracts of British Patent Specifications recently accepted.

10,939 (1911). *Furnaces for Smelting Metals.* F. W. Winner, 18, Kaiser-Friedrich-Ring, Wiesbaden, Germany.—Figure 1 is a longitudinal section taken along the line 1—1 in Figure 3 of the melting chamber of a crucible smelting furnace; Figure 2 is a transverse section taken along the line 2—2 in Figure 3; Figure 3 is a view in section taken on the line 3—3 in Figure 1; Figures 4 and 5 illustrate in partial elevation and vertical section crucibles having the improvement applied,

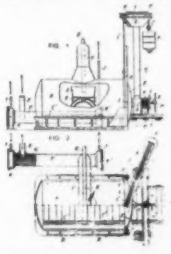


Furnace for Smelting Metals.

Figures 6 and 7 being corresponding plan views. The furnace is shown as being adapted for receiving a number of crucibles up to forty-five, the arch being arranged for the reception ot thirteen crucibles, and specially reinforced at the parts which occur between the portions which are adapted to carry the pots or crucibles, by making the parts thicker than the intervening portions. The position of the arch crucibles relatively to the crucibles on the hearth is clearly shown in Figures 1, 2 and 3, also the arrangement of the reinforced portions of the arch between the parts which carry or support the crucibles disposed in the arch. The beads or inwardly projecting rims or flanges are illustrated in Figures 4 to 7 inclusive, and serve for holding and supporting the crucibles when removing or inserting the same.

15,555 (1911). *Process for Hardening Steel Castings.* J. W. Gebhard, 6,430, Parnell Avenue, Chicago, U.S.A. The invention relates to a process of producing steel castings which have all or a portion of their wearing surfaces hardened and strengthened for a predetermined depth, and to the compound which is used in carrying out the process. In carrying into effect this type of process, sand moulds are utilised in the usual manner as if for ordinary soft steel castings, and to the portions of the mould corresponding to the parts of the casting to be hardened a compound is applied composed of elements which, when absorbed by the molten steel, become incorporated with the steel and, when cold, form a skin or shell on the surface of the casting. The skin or shell may be of any suitable depth or thickness, but ¼ of an inch in depth is sufficient for most purposes. After applying the compound, which is preferably in the form of a thin paste, the mould is placed in a drying oven and subjected to heat sufficient to dry out the mould, after which the molten steel is poured into the mould in the usual manner. The compound has for its basis or principal ingredient, ground ferro-manganese. The ferro-manganese is preferably finely ground, and added to this are small quantities of silica or aluminium, either ground or in liquid form (a mixture of banana oil and ground aluminium is known as liquid aluminium). This mixture is moistened with linseed oil to produce a paste of the desired consistency.

30,198 (1910). *Treatment of Melted Metals, Alloys, and Steels.* L. Baraduc-Muller, 24, Avenue du Trocadero, Paris, France.—A suitable apparatus for removing the gases from metals contained in a ladle or crucible is shown in the accompanying illustrations. Fig. 1 is an elevation of the vacuum chamber; Fig. 2 is a sectional plan. The ladle A containing the molten metal is brought by a carriage B on to a platform C leading into the chamber D to be evacuated. Within it there is a railway C^1 along which the carriage carrying the ladle travels. From the upper part of the chamber springs a pipe E, for the escape of air and hot gases under the suction. This pipe leads to a refrigerator, which consists of a cylinder F containing a bundle of tubes terminating at each end in a box H H^1. Into the box H opens a



Apparatus for the Treatment of Melted Metals, Alloys and Steels.

pipe I through which cold brine is supplied, while from the box H^1 springs a pipe J serving to conduct away the heated brine. The brine cools the bundle of tubes, and therefore the hot gases passing around them. The chilled gases then proceed through a pipe K to the exhausting apparatus. Cold water is preferably sprinkled from a perforated pipe M on the pipe E, so as to prevent its alteration and partially cool the hot gases. At one end the vacuum chamber D is closed by a circular door N of cast iron or steel, having a circumferential groove wherein is a washer of elastic material impermeable to gases, such as rubber, which makes a tight joint against

the end of the cylindrical chamber D. The door N may be displaced vertically when it is not tightly closed, being guided for this purpose by flanges or ears *e* moving in channel iron guides O. In order that the door may be tightly closed against the chamber when it is in its lowered position, the guides O are cut away at the corresponding places to allow the ears *e* to pass. The weight of the door is balanced by a weight P, attached to the door by a chain *f* and passing over pulleys *g* carried by a beam *h*. For closing the door tightly there is provided a screw *k*, operated by a wheel *m* and working in a nut *n* held between channel irons *o*, which constitute a cross beam adapted to turn on a pivot *p*. This beam engages in a support *q* symmetrically arranged in relation to its pivot (Fig. 2), and is held in position by a key *r*. When the beam is in proper position (Fig. 2) the closing key *k* is turned so as to abut against the door and close it tightly.

New Companies.

BROLT, LIMITED.—Capital £15,000 in £1 shares, to carry on the business of engineers, etc.

UNIVERSAL GRINDING WHEEL COMPANY, LIMITED.—Capital £6,000 in £1 shares (3,000 preference).

SEATON & PEET, LIMITED.—Capital £2,000 in £1 shares, to carry on the business of engineers, etc.

PENSNETT FOUNDRY AND TINNING WORKS (LIMITED).—Capital £2,000 in £1 shares (750 ten per cent. pref.).

W. J. WILLIAMS & SONS, LIMITED.—Capital £500 in £1 shares, to carry on the business of tool manufacturers, etc.

BRENTFORD FOUNDRY COMPANY, LIMITED.—Capital £2,000 in £1 shares. Registered office: 334a, High Street, Brentford.

KIRKDALE ENGINEERING COMPANY, LIMITED.—Capital £1,000 in £1 shares. Registered office: Kirkdale Villa, Kirkdale Road, Leytonstone, N.E.

EMPIRE ENGINEERING WORKS, LIMITED.—Capital £20,000 in £1 shares (10,000 preference). Registered office: 36, Gracechurch Street, E.C.

JARVIS ENGINEERING COMPANY, LIMITED.—Capital £1,200 in £1 shares. Registered office: Queen Anne's Chambers, Tothill Street, Westminster.

THAMES BANK (BLACKFRIARS) IRON COMPANY, LIMITED.—Capital £20,000 in £1 shares. Registered office: Bonlea Foundry, Thornaby-on-Tees.

CAPPER, PASS & SON, LIMITED.—Capital £500,000 in 275,000 preference shares of £1 and 22,500 ordinary of £10, to carry on the business of smelters, etc.

J. H. NICHOLSON & COMPANY, LIMITED.—Capital £10,000 in £1 shares, to carry on the business of engineers, etc. Registered office: 110, Cannon Street, E.C.

WILLIAM ROLLINSON & SONS, LIMITED.—Capital £10,000 in £1 shares (5,000 5½ per cent. cumulative preference), to carry on the business of ironfounders, etc.

RUSCOES, LIMITED.—Capital £1,000 in £1 shares, to carry on the business of mechanical engineers. Registered office: Bowden Road, Kennington, London, S.E.

H. FAGG, BIRD & COMPANY, LIMITED.—Capital £500 in £1 shares, to carry on the business of engineers, etc. Registered office: Prospect Cottage, Puckle Lane, Canterbury.

W. H. RAYNER & SONS, LIMITED.—Capital £4,000 in £5 shares, to carry on the business of electrical and general engineers. Registered office: 166, London Road, Nottingham.

G. BIRCH & COMPANY, LIMITED.—Capital £7,000 in £1 shares, to take over the business carried on as G. Birch & Company, at the Islington Tool Works, Islington Grove, Salford.

HARVEY & COMPANY (ASTON MANOR), LIMITED.—Capital £100 in 2s. shares, to carry on the business of iron, brass, and general founders. Registered office: 10, Union Passage, Birmingham.

STIRLINGSHIRE IRON AND STOVE COMPANY, LIMITED.—Capital £11,000, divided into 8,000 ordinary and 3,000 preferred shares of £1 each, to acquire and carry on the business at Bonnyside Foundry, Bonnybridge.

BARFORD & PERKINS, LIMITED.—Capital £60,000 in £1 shares, to take over the business of engineers carried on at Queen Street, Peterborough, as Barford & Perkins. Registered office: Queen Street, Peterborough.

INSHAW ROTARY ENGINE SYNDICATE, LIMITED.—Capital £2,500 in £1 shares, to adopt an agreement with Geo. R. Inshaw, and to carry on the business of engineers electricians, founders, makers and repairers of motors.

ANTONIO RICHARDSON, LIMITED.—Capital £3,000 in £1 shares, to carry on the business of iron and brass founders and engineers as formerly carried on by A. Richardson. Registered office: Victoria Street, Mansfield, Notts.

WILLIAM GILPIN, SENR. & COMPANY, LIMITED.—Capital £40,000 in £1 shares (15,000 5 per cent. non-cumulative preference), to carry on the business of makers of axles and edge tools, etc. Registered office: Churchbridge Works, Cannock, Staffs.

ROBERTS & COOPER, LIMITED.—Capital £112,000 in 4,000 "A" preference, 4,000 "B" preference, and 3,100 ordinary shares of £10 each, and 1,000 employees' shares of £1 each, to carry on the business of iron and steel masters, etc.

WILLIAM TATHAM, LIMITED.—Capital £50,000 in £5 shares, to carry on the business of mechanical engineers, makers of textile and other machinery, etc., and to acquire the business carried on by L. A. Porritt at Vulcan Works, and at Belfield, Rochdale, Lancashire, as William Tatham & Company.

Deaths.

MR. WILLIAM PARKINSON, brassfounder, Peel Street, Farnworth, died recently, aged 83 years.

MR. J. S. SMITH, of J. S. Smith, Limited, Parliament Brass Works, Nottingham, died recently at the age of 53 years.

MR. C. S. CAIRD, a son of Mr. John Caird, managing partner of the firm of Caird & Company, engineers and shipbuilders, Greenock, died recently.

MR. S. BUCKLEY, a director of Buckley & Taylor, Limited, Castle Ironworks, Greenacres Moor, Oldham, died recently, aged 76 years.

MR. R. BLAKEBOROUGH, of Messrs. J. Blakeborough & Sons, Woodhouse Ironworks, Birds Royd, Brighouse, Yorks., died recently, aged 69 years.

MR. J. MOUNTFORD, of Messrs. John Mountford & Company, engineers and smiths, Hulme Street and Colliery Street, Manchester, died recently.

MR. W. H. KNUTTON, manager of the engineering department of the business of Davy Brothers, Limited, Park Ironworks, Sheffield, died on January 2, aged 62 years.

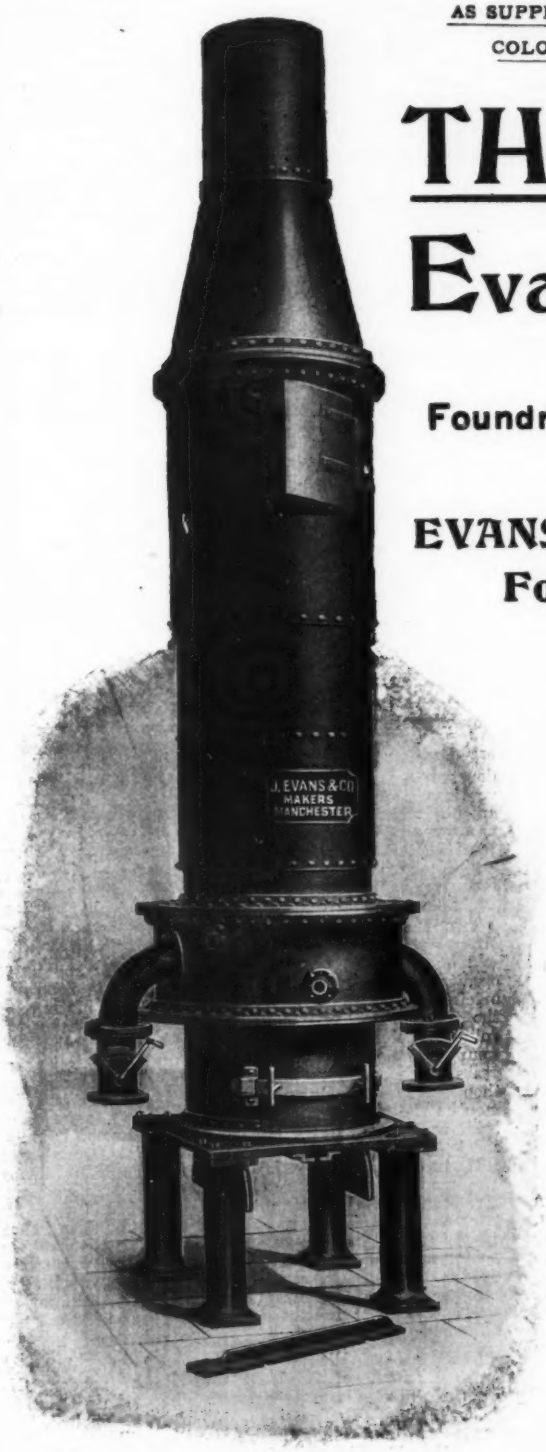
MR. GEORGE JEREMIAH died at his residence at Loughor, on December 23, 1911. The deceased, who had reached the age of 77 years, was proprietor of the Cwmdu Foundry, of which his son, Mr. T. Jeremiah, is at present the head.

THE death occurred, at Nottingham, on January 15, of Mr. S. W. Johnson, who was for over 30 years chief mechanical engineer and locomotive superintendent of the Midland Railway Company, retiring from that position about 10 years ago.

THE death is reported of Mr. W. Smith, a member of the firm of Smith, Peace & Company, engineers, Keighley. The deceased gentleman was also a director of Smith, Marks & Company, Limited, Britannia Ironworks, Keighley. He was about 54 years of age.

THE death took place recently, at his residence, Rose Cottage, Sowerby, Thirsk, of Mr. A. C. Bamlett, at the age of 75. Going to Thirsk a little more than fifty years ago, he commenced business as an agricultural engineer. Mr. Bamlett was a member of the Sanitary Institute, the Iron and Steel Institute, the Institution of Mechanical Engineers, and of the Institution of Civil Engineers.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE,
COLONIES, AND FOREIGN GOVERNMENTS.



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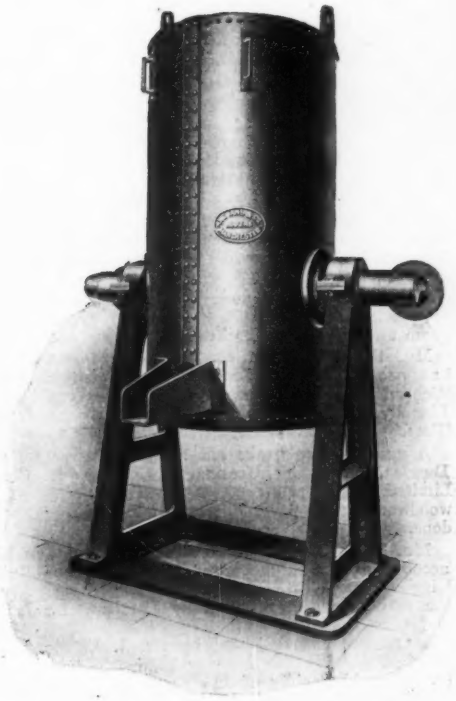
EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."

Trade Talk.

Wm. Jessop & Sons, Limited, Brightside, Sheffield, are opening offices at Daimler House, Paradise Street, Birmingham.

The London business of the Adams Manufacturing Company has been transferred to Balfour House, Finsbury Pavement, E.C.

Edgar Allen & Company, Limited, contemplate carrying out extensive alterations to their Imperial Steel Works, Tinsley, Sheffield.

The British Thomson-Houston Company, Limited, have opened offices and extensive show rooms at Daimler House, Paradise Street, Birmingham.

Considerable damage has been caused by fire to the fitters' shop and metal stores of the Forth and Clyde and Sunnyside Iron Companies, Limited, Falkirk.

Messrs. Moncrieff P. Ford & Company, engineers and machinists, 57, Colmore Row, Birmingham, have removed to 12, Bromsgrove Street, and 64/65, Dean Street, Birmingham.

Messrs. B. Foster and F. Foster, carrying on business as engineers at Whitley Street, Bingley, under the style or firm of F. & B. Foster, have dissolved partnership.

Hadfield's Steel Foundry Company, Limited, of Sheffield, has been awarded a contract by the United States Chief of Ordnance, for the supply of 100 14-in. armour-piercing shot.

Messrs. Vaughan & Company, Albany Works, Wolverhampton, have purchased the business of Messrs. William Lea & Company, brassfounders, Bloomsbury Foundry, Wolverhampton.

A lecture on modern foundry practice was delivered by Mr. H. Munro, of Messrs. Glenfield & Kennedy, Limited, Kilmarnock, before the Glasgow University Engineering Society, recently.

Ernest Scott & Mountain, Limited, Close Works, Gateshead, is being wound up voluntarily. Mr. J. L. Oliver, 32, Grainger Street West, Newcastle-upon-Tyne, has been appointed liquidator.

Messrs. A. Bradley and J. Bradley, carrying on business as engineers, millwrights, and mechanics, at Gooder Lane, Rastrick, Yorkshire, under the style of William Bradley, have dissolved partnership.

The business carried on by the late Mr. James Ferguson, Tayport Foundry, Tayport, has been acquired by his son, Mr. John Ferguson, who will continue the same under the style of James Ferguson & Son.

Mr. R. F. Wilson, 40, St. Enoch Square, Glasgow, has been appointed Scottish and Yorkshire agent of Richard Neville & Company, Limited, Wern Ironworks, Llanelly, and Gowerton Engineering Works, Gowerton, Glam.

A serious fire broke out at the Blackness Foundry, Dundee, owned by Urquhart, Lindsay & Company, Limited, on December 30, 1911. The origin was in the woodworking shop, and very considerable damage was done.

Mr. T. A. Nunwick has started business on his own account as a manufacturers' agent at Ayton Buildings, King Street West, Manchester, and has taken over the agency of the Light Alloy Company for Lancashire and Cheshire.

A lecture was delivered by Dr. J. E. Stead, F.R.S., of Middlesbrough, on January 16, before the members of the Sheffield Society of Engineers and Metallurgists, on "Blowholes in Steel." Mr. G. Blake Walker (president) occupied the chair.

Mr. John Campbell, engineer and millwright, Newtongrange, has acquired the business of the late Mr. John Hope (trading under the style of John Hope & Son), brassfounder, Dalkeith, and will continue the business under the same name.

The partnership heretofore subsisting between Messrs. M. G. Tate and R. S. Marshall, carrying on business as engineering specialists and mill furnishers, at 102, Saint Mary Street, Cardiff, under the style of Tate, Marshall & Company, has been dissolved.

The partnership heretofore subsisting between Messrs. F. Hawkes, J. G. Lee, and E. Pack, carrying on business as engineers, at Rushden, Northampton, under the style of the Central Machinery Company, has been dissolved, so far as regards Mr. J. G. Lee.

Messrs. W. H. Helliwell and T. Marshall, carrying on business as iron founders, at Holmfield Iron Foundry, Holmfield, Halifax, under the style of Helliwell & Marshall, have dissolved partnership. Mr. W. H. Helliwell will carry on the business in his own name.

Robert Sorby & Sons, Limited, crucible steel makers, of the Kangaroo Works, Sheffield, have acquired the business of James Howarth & Sons, Limited, Broom Spring Works, Bath Street, Sheffield, and will continue it under the same style.

At a meeting of the shareholders of the Armadale Iron Company, Limited, held at the works, Armadale, West Lothian, on December 28, resolutions were duly passed to the effect that the company be would up voluntarily, and that Mr. A. W. R. Durham, C.A., Edinburgh, be appointed liquidator.

Messrs. J. H. Evans & Company, of 22, Billiter Street, and 49, Leadenhall Street, E.C., have been appointed the sole London agents for the following firms:—Geo. A. Shipman & Company, Limited, of Sheffield, for the sale of crucible cast steel and wire, nickel steel, etc.; the Vincit Company, Limited, of 70, Queen Victoria Street, E.C., for the sale of carborundum and electrite and high-class machinery, etc.; Mons. X. J. L. Deneyer, of Charleroi, Belgium, for the sale of pig-iron for foundries, Belgian iron and steel, bolts, nuts, rivets, wire, tinplates, lead, tin, etc.

A meeting was held in London, on January 15, for the purpose of founding an Inventors' Institute. Major W. A. Denny (late Director-General of Intelligence to the Government of Canada) presided, and was supported by Mr. Vale Nicolas, an authority on patent law. Mr. Nicolas explained that the proposed institution would be devoted to furthering the interests of inventors and inventions. A long experience had shown him that such an institution was not only desirable, but absolutely necessary. In many ways the organisation could assist the inventor, protecting his rights and liberties. The periodical reading of papers on subjects of importance to inventors should prove of great service. The necessary resolutions were carried.

The second meeting of creditors of Messrs. John Musgrave & Sons, Limited, engineers, of Bolton, was held on January 3, and was attended by about 150 creditors. At the close of the meeting, the following official statement was made:—"Mr. Harold Mather, of the firm of Mather & Kay, chartered accountants, the voluntary liquidator, presided. He explained that the company was formed in 1897, and up to the last three years had made profits, but a season of bad trade had then set in, and during the last two years and five months the company had made very heavy losses. The total assets as a going concern, shown on the balance-sheet (exclusive of uncalled capital), as at December 8, 1911, showed a substantial surplus over all liabilities. The creditors present agreed unanimously to continue Mr. Mather as liquidator. The receiver and manager (Mr. Arthur Kirkham) appointed by the Court on behalf of the debenture-holders, is still in possession of the business, and assets of the company, and it was stated by the liquidator that he proposed to confer with the receiver, and to endeavour at an early date to formulate a scheme of reconstruction for the consideration of all concerned."

The old-established business of G. Aston & Sons, Limited, of Eagle Wharf Road, London, N., has recently been acquired by the Cleveland Bridge and Engineering Company, Limited, of Darlington, and the business will still be carried on at the old address, under the management of Messrs. W. H. & H. Woodward Aston, by a newly-formed syndicate, under the title of the Aston Construction Company, Limited. The works have an area of 1¼ acres, and a frontage of 330 ft. to the Regent's Canal.

PURE METALS

and ALLOYS. FREE from CARBON.

TITANIUM THERMIT

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SOUND. STRONG, CLOSE-GRAINED CASTINGS.

Also FERRO VANADIUM and FERRO TITANIUM.

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Telephone: 3749 Central,

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ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

The works' equipment consists of a large girder shop, machine shop, foundry and pattern shop, and the new company, being large stockholders, are making a special feature of prompt delivery, plain joists and sectional material being available for delivery at an hour's notice. The new company has been formed with the idea of catering for the trade in steel-framed buildings, while they will continue to make a speciality of escape and service staircases, such as are very largely required under the Building Act of the London County Council. The general business will be that of constructional steel and concrete work, but the Aston Construction Company are also suppliers of general castings, as they have adequate facilities for any machining work which may be required.

THE President of the United States has consented to act as patron to the sixth congress of the International Association for Testing Materials. The Executive Committee consists of the president of the Congress, Professor H. M. Howe, acting-president of the Association; the vice-president, Mr. W. Lesley; Mr. H. F. J. Porter, the newly-appointed secretary of the Organising Committee; Professor E. Marburg, treasurer, Finance Committee; Mr. F. E. Schmitt, Papers Committee; Mr. F. H. Clark, Transportation Committee; Mr. Rich. L. Humphrey, Information Committee; Dr. J. A. Holmes, Local Committee of Washington; Dr. Rud. Hering, Local Committee of New York; and Capt. Rob. W. Hunt, Reception Committee. The Congress will open in the Engineering Societies' Building in New York City on Tuesday morning, September 3, 1912, and continue in session if necessary during the remainder of the week and in connection with the inspection of various works and sights. Following upon this there will be arrangements made for a week's excursion over the Lehigh Valley Railroad, with a visit to the Bethlehem Steel Company, and some of the cement plants in that district. The programme will also cover the Niagara Falls and Buffalo, where the Lackawanna Iron & Steel Company is located; Pittsburg, and finally Washington, where a visit will be made to the Government Departments, including the Bureau of Standards, Testing Bureau of the Army and Navy, Smithsonian Institute, etc. A reception will subsequently be given by President Taft.

Legal.

Scottish Ironmoulders Litigation.

The litigation which has been proceeding for some time in the Edinburgh Court of Session, at the instance of J. Johnstone, ironmoulder, against the Associated Ironmoulders of Scotland, and the trustees of that body, has come to an end. The pursuer sought declarator that the rule of the society providing for Labour representation in Parliament was *ultra vires*, illegal, and invalid, and was not binding upon the pursuer or any other member of the Society, and that the Society was not entitled to make payment out of its funds or levies to the Labour party or for the payment of Parliamentary election expenses. Some time ago Lord Skerrington granted decree of declarator as concluded for, with expenses, and continued the case. This judgment was reclaimed against, but the reclaiming note was withdrawn, and last week counsel for the Association appeared before Lord Skerrington and gave an undertaking that no payments such as those complained of would be made from the funds of the Association. In respect of the undertaking the Lord Ordinary found it unnecessary to deal with the question of interdict, and awarded expenses to the complainer.

Rating of Engineering Works.

At the Leeds City Quarter Sessions recently, the Recorder (Mr. Tindal Atkinson, K.C.) concluded the hearing of the appeal of Greenwood & Batley, Limited, engineers, Leeds, against the assessment of their works by the Assessment Committee of the Bramley Union. The gross estimated rental of the premises was stated as £10,134, and the rateable value £6,050. Mr. Waugh, for the respondents, pointed out that the Assessment Committee were entitled to appoint a valuer in order to assist the overseers. The onus was upon the appellants to show that any injustice had been done to them by the Assessment Committee, who had made every endeavour to come to a fair valuation of the hereditaments which were the subject of the appeal. Whether the Committee were right or not, they must have the credit of attempting to act in a judicial manner. Unless the Court were convinced that the Committee were absolutely wrong, their decision could not be reversed. It did not matter in the least how unsuitable the premises might be; the same amount had to be expended, by the landlord or the tenant, upon efficient machinery.

Mr. Balfour Browne, for the appellants, contended that it was wrong to separate, for the purpose of rating, the value of the machinery and the value of the building. Respondents' counsel had argued that machinery was worth as much in a bad building as in a good one. But a tenant would look at the result of the working.

The Recorder said that there were three items to be taken into consideration in assessing the gross value of the premises. These were the rent of the land, the rent of the building, and the addition to the rent of the building by the presence of machinery. As regarded the rent of the land, there were two sets of figures. A London valuer estimated it at £350, but a local valuer, who was well acquainted with the district, set it at £880. He should rule that a proper value was £500. As regarded the rent of the building, he accepted the appellants' figures, £4,470. He had been asked to deal with the question of the machinery as one of principle. But it was impossible to lay down a principle which would settle or go anywhere near settling other cases of a similar character. It was a question of fact. He must say he should have thought the overseers and the valuers who assisted them would have taken the advice of practical people, but they had not called one. However, it was not for him to advise them. Mr. McLaren had told them that in his opinion the rent of the building was increased 100 per cent. by the presence of the machinery. That was to say that the building and machinery were equal in value. But Mr. McLaren had subsequently qualified this by estimating the rent of the building at £3,600 and the additional value by the presence of the machinery at £3,000. He had decided to assess the extra value at £3,976. This would make up a gross total of £8,946, made up as follows:—Rent of land £500, building £4,470, and machinery £3,976. The net value would be £4,872. The appeal would be allowed with costs.

Personal.

MR. H. G. BURFORD has resigned his position as general manager of Humber, Limited.

THE late Mr. A. E. Maxfield, chairman of Sanderson Bros. & Newbould, Limited, Sheffield, left estate valued at £25,015 gross.

THE late Mr. J. H. Barber, for many years a director of Brown, Bayley's Steel Works, Limited, left estate valued at £7,062.

THE late Mr. Charles Wardlow, of Messrs. S. & C. Wardlow, Portobello Steelworks, Sheffield, left estate valued at £68,707 gross.

AN estate valued at £73,610 8s. 5d., including net personalty £53,906 19s. 6d., has been left by Mr. J. B. Bruce, Edgbaston, Birmingham, brassfounder.

MR. E. HOLLINGS has been elected managing-director, and Mr. T. F. Robinson chairman, of G. Birch & Company, Limited, Islington Tool Works, Islington Grove, Salford, Manchester.

THE late Mr. T. Outhwaite, one of the heads of the commercial department of the business of Bolckow Vaughan & Company, Limited, left estate valued at £26,549 6s. 4d. gross.

MR. J. D. THOMPSON, file manager at the Norfolk Works of Thomas Firth & Sons, Limited, Sheffield, has been the recipient of presentations from the officials and men on the occasion of his retirement

T. E. MANSERGH.

EVERY DESCRIPTION OF
MOULDERS'
PATENT WOOD, MINERAL and
COAL DUST BLACKINGS
MANUFACTURED.

Wheathill Charcoal Works, SALFORD.

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OF ALL GRADES.

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Finest Workmanship and Materials.

SEND for QUOTATIONS
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A NEW STEEL BARROW

(PATENTED)

"BRABY'S BALANCED BARROW.

The Handiest and Cheapest Barrow in the market. Specially designed for coal, dross, ashes, etc. Its capacity is **25 per cent. greater** than the ordinary style, yet it can be wheeled with **half the labour**, and can be emptied **much more quickly**. It is a **perfectly balanced** barrow, and a full load can be **easily wheeled by a boy.**

NOTE.—This Barrow can be taken right up to mouth of furnace and the ashes drawn into the barrow direct from the furnace.

The "B.B.B."

BRABY for high grade **STEEL**
SHEETS & PLATES up to 15 FEET LONG.
RANGE of GAUGES 8 to 30 W.G.
RANGE of WIDTHS 12 to 60 in.

BRABY for improved wrought **STEEL**
BARROWS, BOGIES, TRUCKS, GUTTERS, PIPES, &c.

BRABY for Iron and **STEEL**
ROOFS and BUILDINGS.

BRABY for unbreakable **STEEL**
SASHES, CASEMENTS, and PUTTYLESS ROOFLIGHTS.

BRABY for galvanized corrugated **STEEL**
SHEETS: "EMPRESS" & "SUN" BRANDS

FREDERICK BRABY & Co. Ltd., Eclipse Iron & Galvanising Works & Steel Sheet Rolling Mills, Petershill Road, GLASGOW.

Show Rooms and Aluminium Warehouse, 124, St. Vincent Street, Glasgow.
Rustless Iron, Galvanising and Copper Works, FALKIRK.

Also at London, Deptford, Liverpool, Bristol, Belfast and Dublin. CONTRACTORS to BRITISH and FOREIGN GOVERNMENTS. Teleg.—" Braby, Glasgow."

Mr. A. R. Bellamy, a director of Richard Hornsby & Sons, Limited, of Grantham and Reddish, has been the recipient of a presentation from the officials and men on the occasion of the completion of 25 years' connection with the firm.

Major J. R. Stansfield, the Government Inspector of Steel in Sheffield, entertained his staff at a dinner on January 6. Major Stansfield, who presided, is about to return to his regiment, having completed his term of office in Sheffield, and thus several references were made to his departure.

The Executive Committee of the Governing Body of the Imperial College of Science and Technology have appointed Professor W. A. Bone, D.Sc., Ph.D., F.R.S., of Leeds University, Professor of Fuel and Refractory Materials in connection with a new department of Applied Chemistry, or Chemical Technology, now being established in the Imperial College at South Kensington.

The valuable services which Colonel W. Sidebottom, J.P., has rendered as a member of the board of Cammell, Laird & Company, Limited, were recognised at an interesting gathering at Sheffield on January 8. The members of the Sheffield executive of the firm entertained him to dinner, and presented him with a handsome silver cup, "as a small token of their high esteem, and in appreciation of the unfailing courtesy and consideration he has at all times shown to them during the 15 years he has been associated with the company as director, deputy chairman, and chairman."

Mr. E. C. Ibbotson has been appointed secretary of the Sheffield Society of Engineers and Metallurgists, in succession to Mr. F. K. Knowles, who, after holding the office for some 20 years, has retired in consequence of his new duties in the metallurgical department of Sheffield University. Mr. Ibbotson is a grandson of the late Mr. William Ibbotson, the founder of the firm of Ibbotson Brothers & Company, Limited, Globe Steel Works. He served his apprenticeship in the manufacturing departments at those works, and was afterwards successively rolling mill manager and steel works manager. He spent several years in Sweden, but some two years ago he returned to Sheffield, and established a practice as consulting metallurgical engineer.

The executive of the Associated Ironmoulders of Scotland have resolved that time workers should accept the offer of a farthing per hour increase, but that the offer of 2½ per cent. increase on piece rates as from May 1 be rejected, and that the members cease work on Saturday unless the same advance as was granted from March 1 be granted now. The ballot of the Scottish ironmoulders on the question of a strike to enforce a general increase of wages has resulted as follows: For a strike, 6,704; against, 1,185.

The National Insurance Advisory Council has been formed for the purpose of advising employers, employees and others as to their position under the National Insurance Act. The offices are at 3, Northampton Square, London, E.C.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years:—

Metals.	End Jan., 1912.	End Jan., 1911.
Iron—Scotch pig warrants ton	*54/9	*55/7½
—Middlesbro' warrants ... ton	48/9	49/4
—W.C. M/nos Bessemer ... ton	67/0	68/6
—Stock, Scotch ... ...tons	1,000	1,000
Copper—Chili bars, GMB ton	£61 12 6	£55 5 0
—Stock, Europe and afloat tons	55,583	83,238
Tin—English ingots ... ton	£197 10 0	£194 15 0
—Straits ... ... ton	£194 10 0	£191 10 0
—Stock, London, Holland, U.S.A., and afloat ...tons	16,925	17,910
Lead—English pig ... ton	£15 17 6	£13 5 0
Spelter—Ord. Silesian ... ton	£26 2 6	£23 7 6
Quicksilver (75lb)... bottle	£8 5 0	£8 0 0
Antimony—Regulus ... ton	£27 10 0 £28 0 0	£28 0 0-£29 0 0

* Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings:—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	6 15 0
Pipes, 1¼ to 2½ in.	4 17 6	to	5 2 6
,, 3 to 4 in.	4 10 0	to	5 0 0
,, 5 to 8 in.	4 7 6	to	4 10 0
,, 10 to 16 in.	4 7 6	to	4 10 0
,, 18 to 24 in.	4 7 6	to	4 10 0
Chairs	3 12 6	to	3 15 0
Floor plates (open sand)	3 0 0	to	3 2 6

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows: Heavy wrought (mixed), £2 9s. 0d.; light wrought, £1 5s. 0d.; heavy cast, £2 6s. 0d.; all per ton, f.o.b., London. Copper (clean), £56 0s. 0d.; brass (clean), £41 0s. 0d.; lead (usual draft), £14 5s. 0d.; zinc, £20 10s. 0d.; all per ton delivered merchant's yard

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Terra Flake,
NEW CORE GUM,
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FIRE CLAY.
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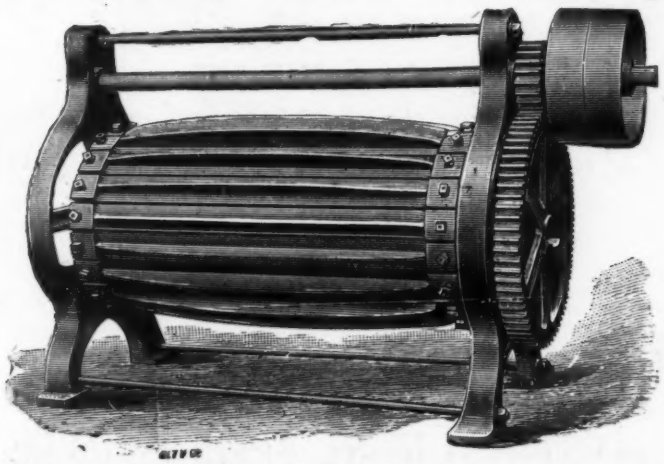

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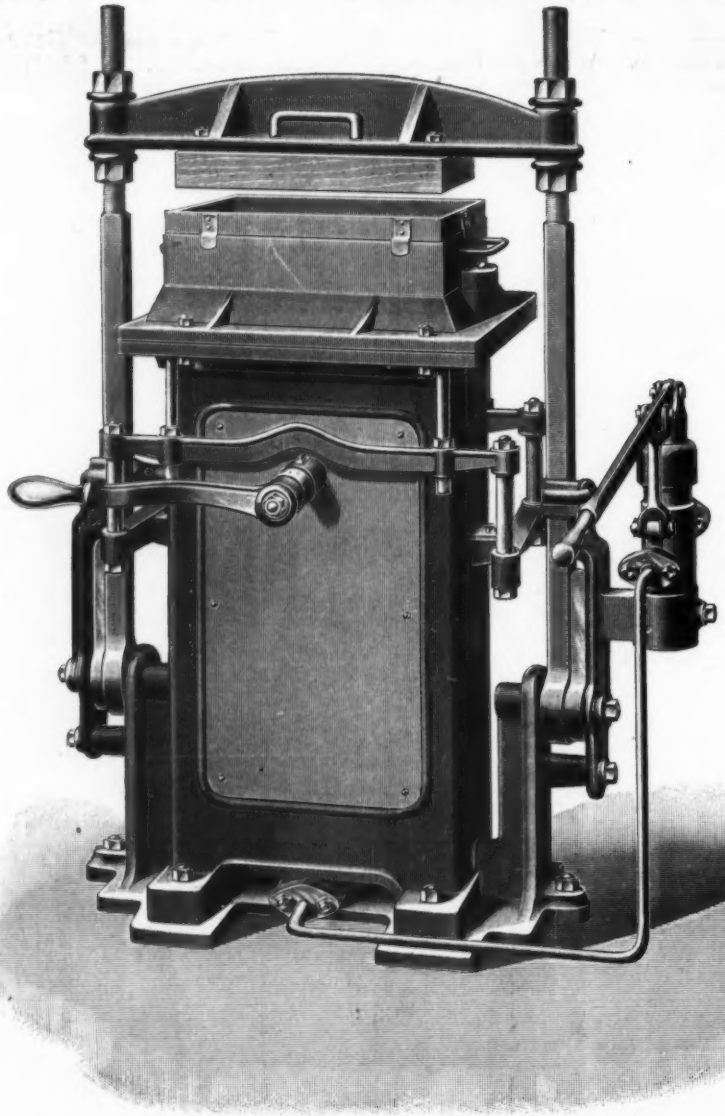

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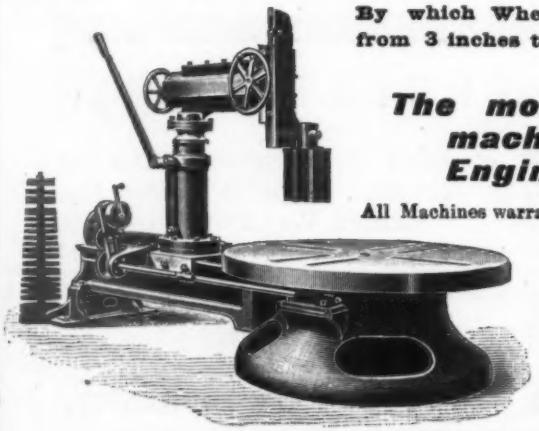

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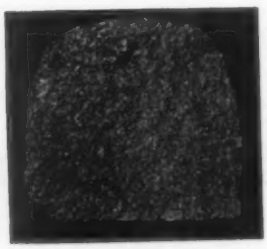
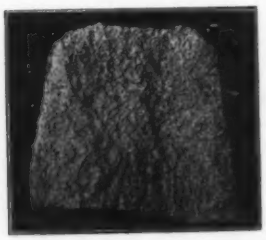
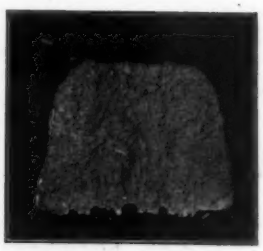

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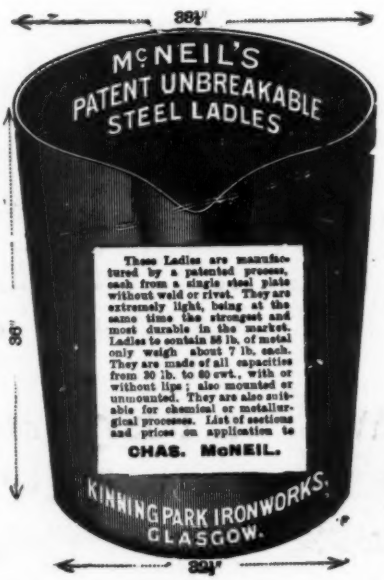
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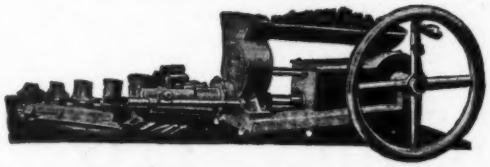

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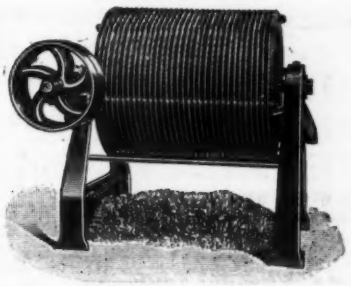

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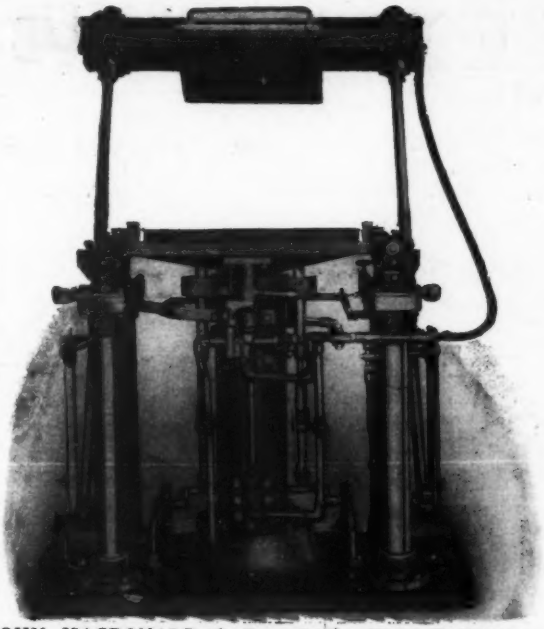

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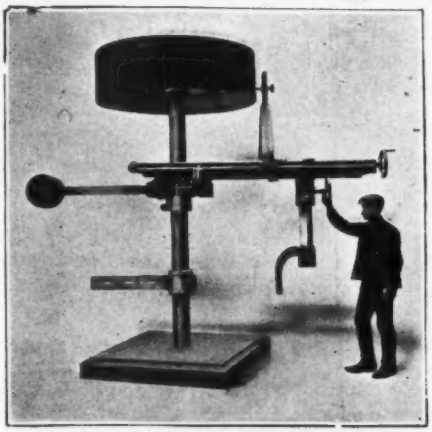

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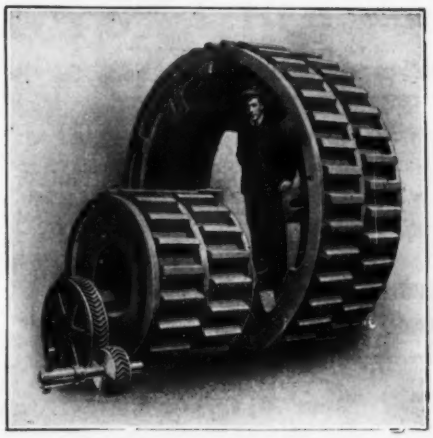

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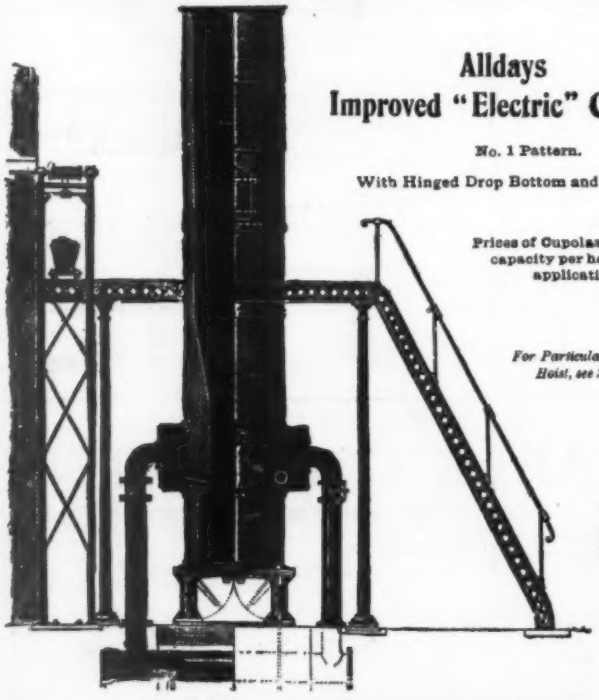

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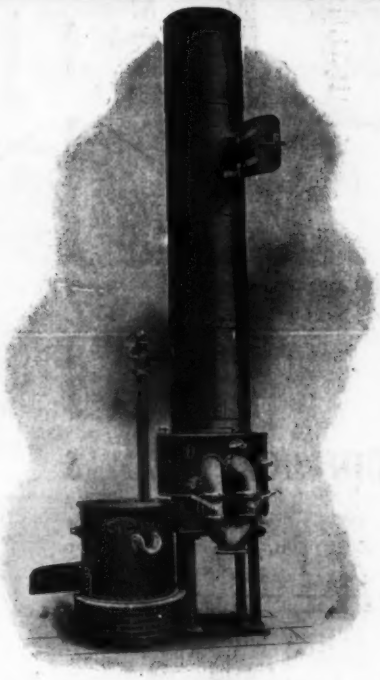

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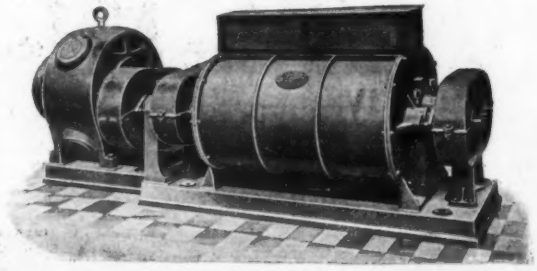

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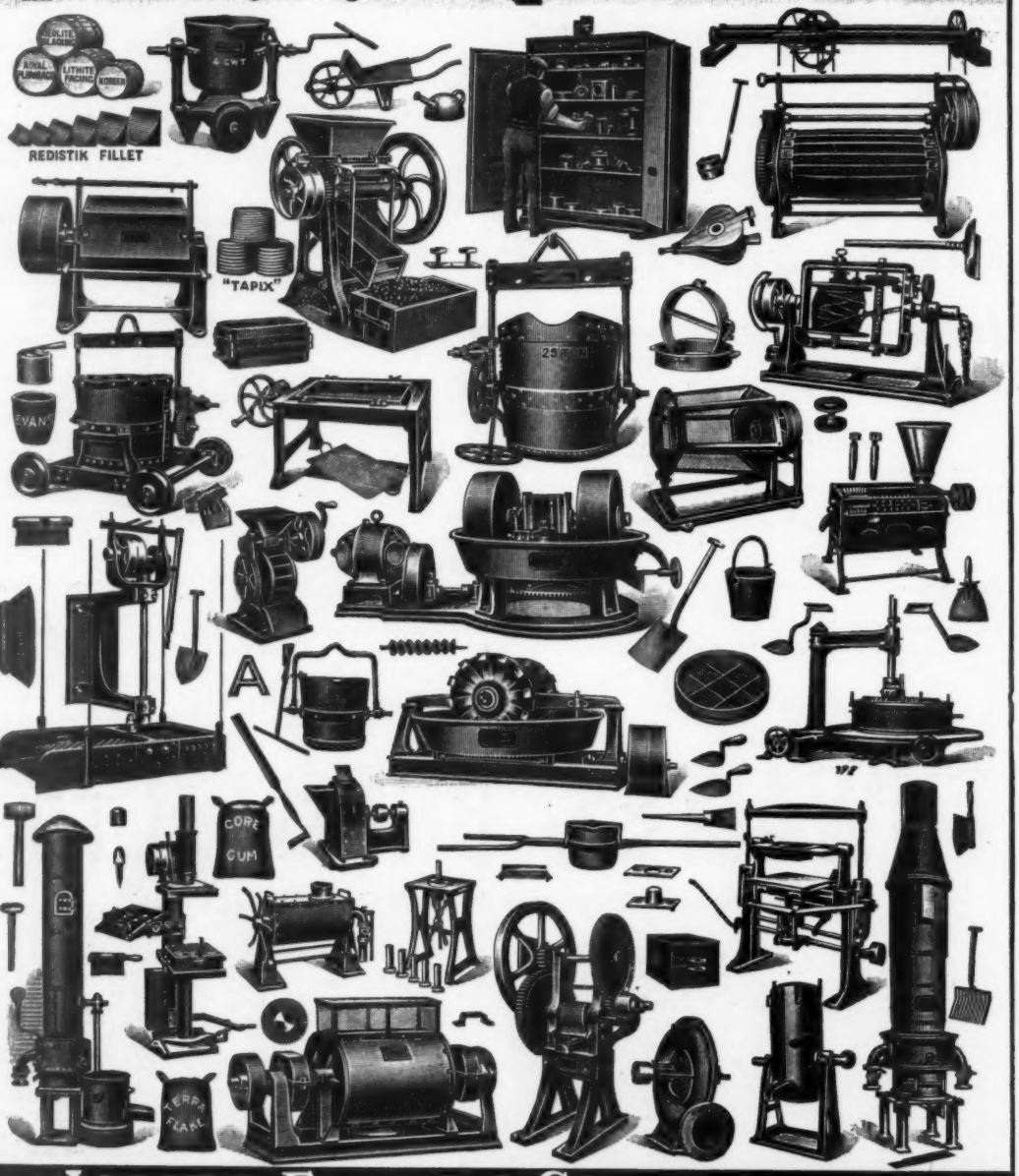

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